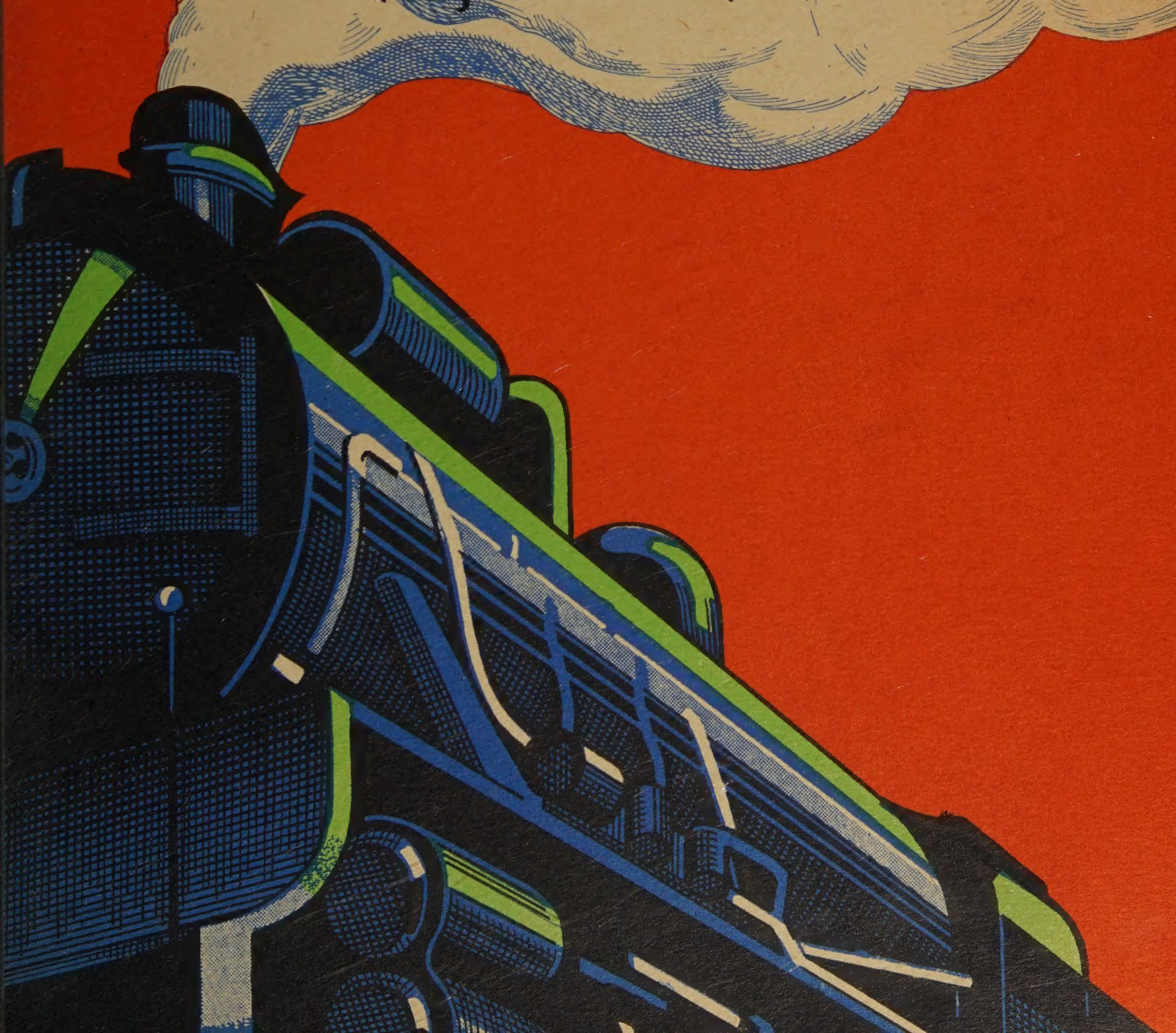
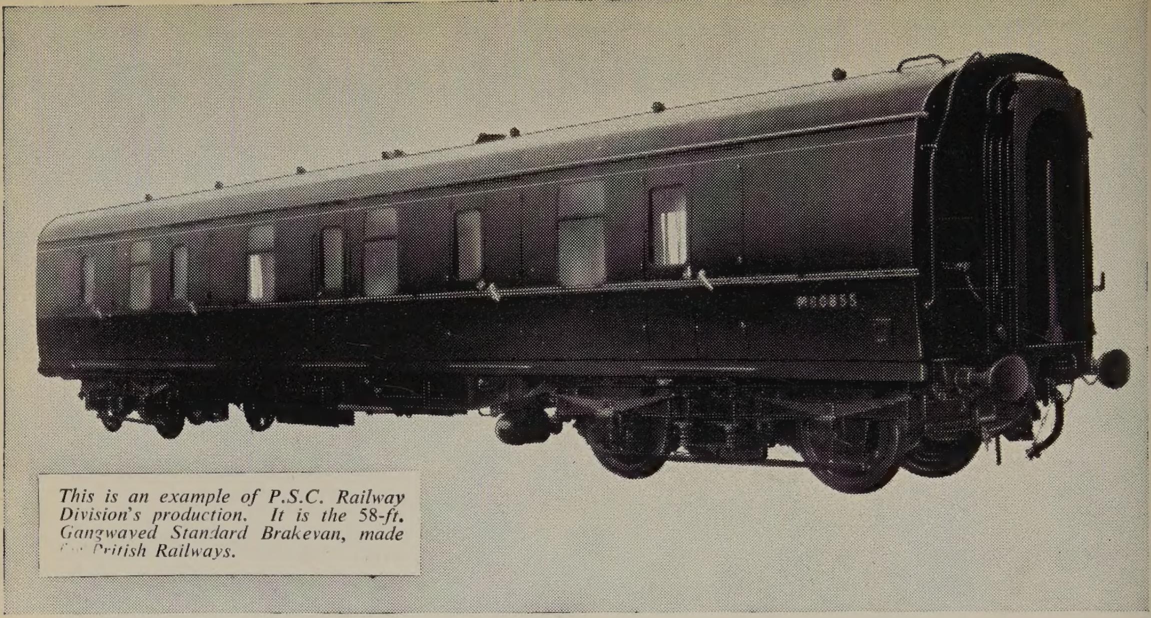
VOL. XXXVI. — No. 2.

FEBRUARY 1959.

Monthly Bulletin of the International Railway Congress Association

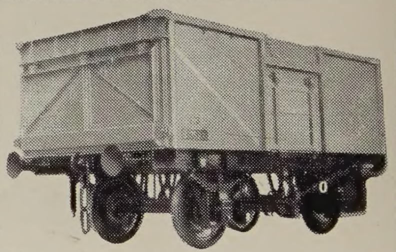
(English Edition)





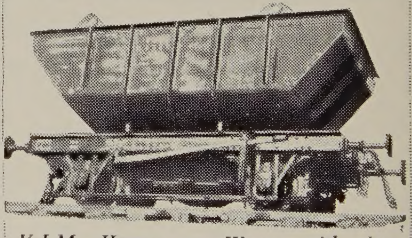
This is an example of P.S.C. Railway Division's production. It is the 58-ft. Gangwaved Standard Brakevan, made for British Railways.

Pressed Steel deliver the goods all over the world



16-ton all steel Mineral Wagon. 72,000 of these have already been delivered from our Paisley works.

In the last ten years Pressed Steel have manufactured enough railway wagons to make a train more than 300 miles long; which isn't just a frivolous statistic, for it reveals the enormous capacity of Pressed Steel Company's works at Paisley for large and varied orders. Indeed, as their record shows, Pressed Steel can make rolling stock in any quantity to any specification for any gauge in any part of the world—quickly and at competitive prices. This page shows just some of the wagons made for some of their customers at home and overseas.



V.J.M. Hopper-type Wagon with drop bottom door for coal, as used by Queensland Government Railways, Australia.

PRESSED STEEL COMPANY LIMITED

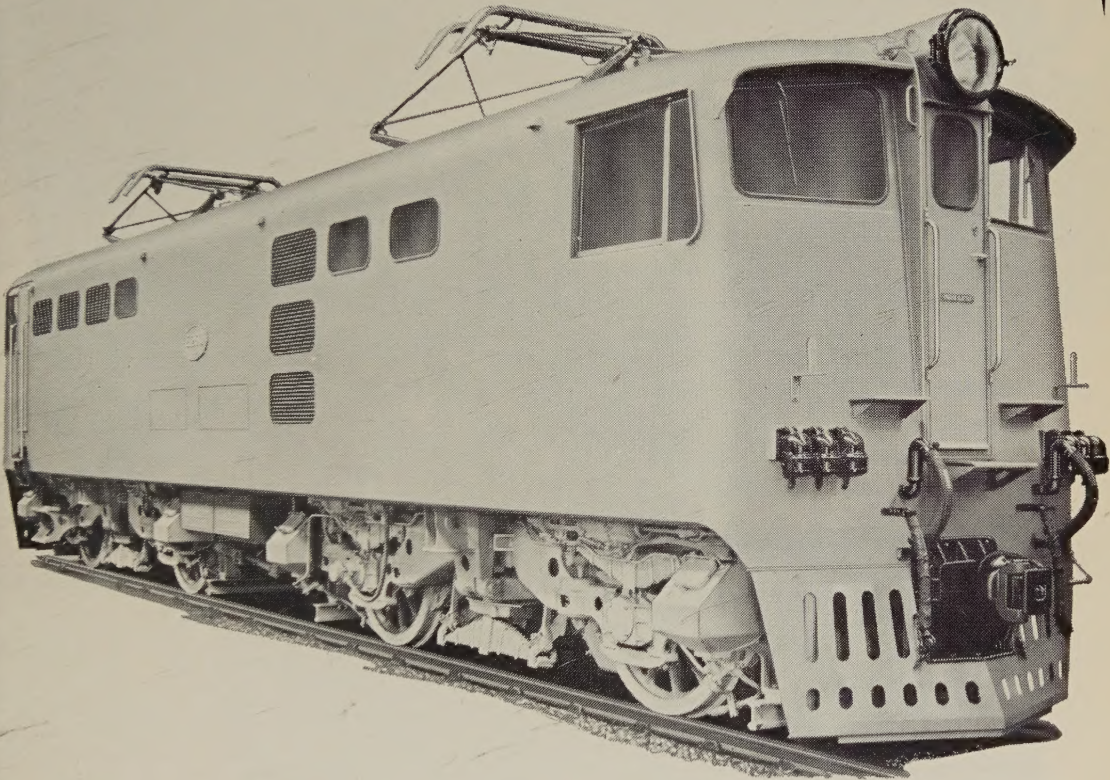
RAILWAY DIVISION, PAISLEY, SCOTLAND

Head Office: COWLEY, OXFORD

London Office, Railway Division: 47 VICTORIA STREET, S.W.1.

Manufacturers also of Motor Car Bodies, Prestcold Refrigeration Equipment and Pressings of all kinds.

Broad gauge Covered Wagon type C.R. as used by Indian Railways.



PRODUCTIVITY IN TRANSPORT

Hauling a passenger express at 100 m.p.h. or 1,250 tons of freight at 55 m.p.h. are two of the varied duties required of the 3,300 h.p. high-voltage A.C. locomotives which the G.E.C. is supplying to British Railways. The modern main-line locomotive must be able to take on most jobs which come to hand. Its output in terms of work per day is scrutinised as carefully as the production of a factory. The combination of G.E.C. electrical skill with the long railway traditions of the North British Locomotive Co. Ltd. has produced a design equal to the demand for the acceleration of passenger and freight trains which is an objective of railways all over the world.

G.E.C.

THE GENERAL ELECTRIC CO LTD OF ENGLAND · MAGNET HOUSE · KINGSWAY · LONDON · W.C.2

TR.241


WORKINGTON

Alphabetical Index of Advertisers

MONTHLY BULLETIN

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

(ENGLISH EDITION)

PUBLISHING and EDITORIAL OFFICES : 19, RUE DU BEAU-SITE, BRUSSELS

Price of this single copy : 80 Belgian Francs (not including postage).

Yearly subscription for 1959	**Belgium . . . .**	**700 Belgian Francs**
	Universal Postal Union	**800 Belgian Francs**

Subscriptions and orders for single copies to be addressed to the General Secretary, International Railway Congress Association, 19, rue du Beau-Site, Brussels (Belgium).

Advertisements : All communications should be addressed to the Association, **19, rue du Beau-Site, Brussels.**

CONTENTS OF THE NUMBER FOR FEBRUARY 1959.

CONTENTS	Page.

CONTENTS *(continued)*. | Page.

LIBRARY

OF THE

Permanent Commission of the International Railway Congress Association

READING ROOM : 19, rue du Beau-Site, Brussels.

Works in connection with railway matters, which are presented to the Permanent Commission are mentioned in the « Bulletin ». They are filed and placed in the library. If the Executive Committee deems it advisable they are made the subject of a special notice. Books and publications placed in the reading room may be consulted by any person in possession of an introduction delivered by a member of the Association.

Books, etc., may not be taken away except by special permission of the Executive Committee.

The Permanent Commission of the Association is not responsible for the opinions expressed in the articles published in the « Bulletin ».

An edition in French is also published.

Vol. XXXVI. — No. 2. February 1959.

BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[625 .253]

A proposed electro-pneumatic brake for railways,

by J. Denis,

Assistant, Technical Management of the Ragheno Works, Malines (Belgium).

This article is a continuation of and is based on the same general principles formulated in the article by Mr. S. Keller given in the May 1957 number of this review (*).

The project now being described is a concrete proposition of an electro-pneumatic brake.

In all proposals of this nature, it is necessary to maintain the pneumatic braking so that this can be used so long as all vehicles are not equipped with the electro-pneumatic brake.

In the scheme now being described, the electro-pneumatic brake is considered as being most probably the only brake in a future possibly far off but certain to come. Consequently, the whole layout has been designed in such a way as to make it possible to profit from all the advantages of the new system, and the brake is double, that is to say the pneumatic brake as well as the electro-pneumatic brake are complete and separate. After a more or less long transition period, when the rolling stock with the new brake is adequate the pneumatic equipment can be left off every new vehicle built.

Let us recall briefly the reasons which lead us to prefer an electric or an electro-pneumatic brake to the existing pneumatic system. The major defect in the present system is the low speed of propagation, in a long train, of the control of the application or release. This drawback limits the length of the train and indirectly the maximum speeds as well. Great progress has been made in the direction of improving the rate of propagation.

These improved performances have been made with attendant complications and by accepting various compromises.

The speed obtained exceeding 250 m/sec being far off the ideal, in order to get steadiness when braking long trains, the braking times have to be lengthened and this is a serious handicap as regards increased train speeds.

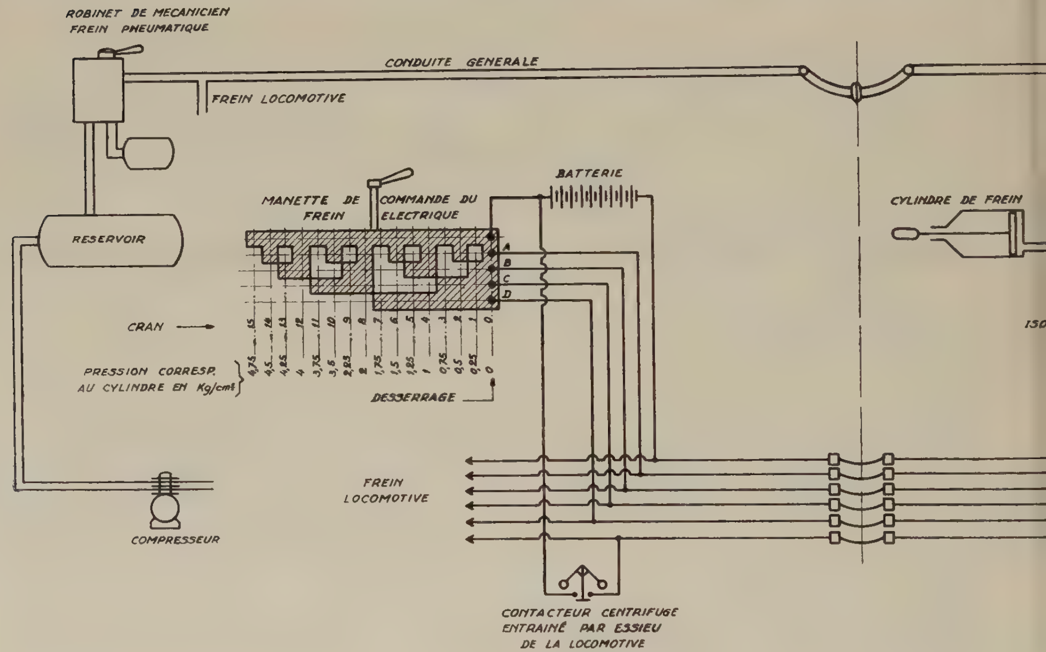
Possibly in the future the present day performances of pneumatic systems may be further improved. However, it is

(*) See *Bulletin*, May 1957, p. 349 : « Factors in the development of an electro-pneumatic compressed air railway brake », by S. Keller from the review : *Economie et Technique des Transports*, No. 115 (4-6), 1956.

theoretically impossible, for the control impulses to exceed 330 m/sec, the speed of sound. In practice, clearly, owing to the resistance due to the surface of the walls of the piping, this speed cannot be attained. It then becomes logical to abandon the pneumatic system and to adopt the electric control, the speed of propagation of which is practically unlimited.

In the project before us, the electrical operation is separate from the pneumatic, and the graduation is done by notches. Each notch position of the control handle corresponds to a definite pressure in the brake cylinders of all the vehicles. The time of response of the brake gearing to the control impulses only depends upon the time required for the air to flow from the auxiliary reservoir to the brake cylinder and the time taken to fill this latter. This time

FREIN ELECT



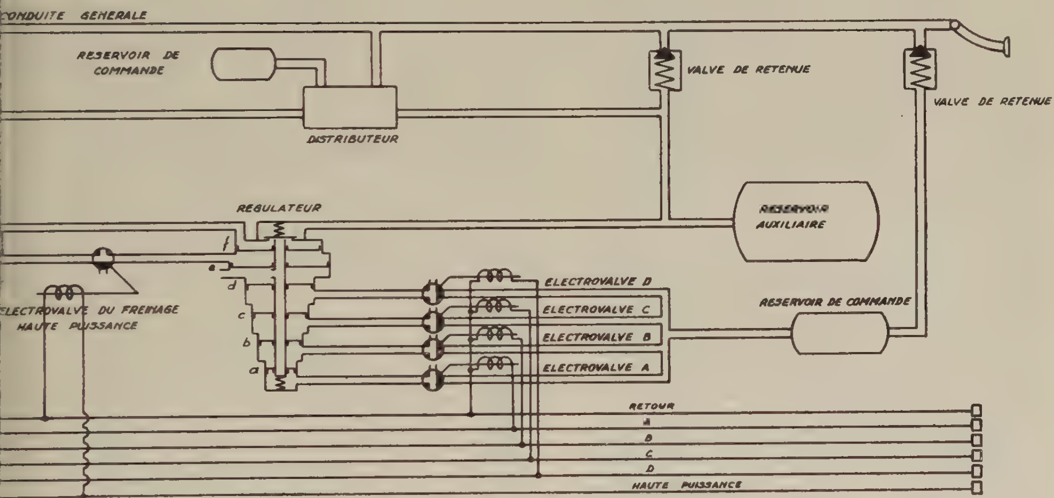
Expla

Frein électro-pneumatique = electro-pneumatic brake. — Robinet de mécanicien = drivers br
brake. — Réservoir de commande = control reservoir. — Valve de retenue = retaining
Cylindre de frein = brake cylinder. — Double valve = double valve. — Distributeur = distr
= notch. — Pression corresp. au cylindre en kg/cm² = corresponding pressure in cylinders i
nage haute puissance = electro valve for high pressure braking. — Electrovalve D, C, B, A
Contacteur centrifuge entraîné par essieu de la locomotive = centrifugal switch driven off a

is relatively short and what is more important will be the same for all the vehicles whatever the train length.

The functioning of the installation as shown in the diagram of figure 1 is

MATIQUE.



ns :
neumatique = Air brake. — Conduite générale = train pipe. — Frein locomotive = locomotive
commande du frein électrique = control handle of the electric brake. — Batterie = battery. —
= regulator. — Réservoir auxiliaire = auxiliary reservoir. — Réservoir = reservoir. — Cran
ge = release. — Isolement frein électrique = cut-out electric brake. — Electrovalve du frei-
, B, A. — Réservoir de commande = control reservoir. — Compresseur = compressor. —
etour A, B, C, D = return A, B, C, D. — Haute puissance = high power.

as follows: Four electrovalves A, B, C and D cause when not excited the pressure in the brake cylinder to be 0.25 kg/cm², 0.50, 1 and 2 kg/cm² respectively. These pressures add themselves together when more than one electrovalve is de-energised. In this way, it is possible to obtain sixteen combinations providing from 0 to 3.75 kg/cm² by stages of 0.25 kg/cm², that is to say one notch for release and fifteen notches for application. The graduation of the pressure is effected in the regulator. When an electrovalve B for example is de-energised, the air from the control reservoir enters the regulator below the piston corresponding to

this electrovalve, i.e. in our example under piston *b*.

This piston rises taking with it the hollow central spindle which opens the upper valve. The air of the auxiliary reservoir can then through the open valve flow into the cylinder. The pressure in the cylinder acts on the piston *f* and tends to push the centre spindle down. At a certain moment the pressures on the piston *f* and on the piston corresponding to the electrovalve are equal, the hollow spindle becomes in equilibrium and the upper valve closes.

In our example, this equilibrium is reached at a pressure of 0.5 kg/cm² in the cylinder. This cylinder pressure will be kept constant so long as the locomotive handle rests in the same notch, that is in our case notch 2. If the pressure in the cylinder rises, the piston *f* pushes down the hollow spindle and the air escapes from the cylinder, to the atmosphere through the passage in the spindle. If the cylinder pressure falls through leakage, the top opens and the desired pressure is restored. The control reservoir has to be provided in order to make the cylinder pressure independent of that in the train pipe and the auxiliary reservoir at the time of braking.

Actually a reduction of the pressure in the auxiliary reservoir occurs when braking. This loss of pressure is immediately made good from air incoming from the train pipe, but this compensation will take place faster at the head than at the tail of the train. If the electrovalves were connected directly to the auxiliary reservoir without the control reservoir, the regulators would be affected by this difference of pressure and the build up pressure in the cylinders would not be exactly the same at the head and at the tail of the train.

The operating equipment on the locomotive is extremely simple. The brake handle operates a drum controller which closes or opens the electrovalve circuits. This controller has notch 0 for release and notches 1 to 15 corresponding to the 15 braking stages. Obviously, 15 is the emergency application notch.

With this installation we can easily provide high power or load braking.

The diagram of figure 1 is for high power braking and the description above relates to this form of working. When the speed of the train falls below the value at which the regime changes, the centrifugal switch contactor opens the circuit of the high power range and the corresponding electrovalves are de-energised on each vehicle fitted (it is not necessary for all the vehicles of a train to be fitted with them). Due to this, the pressure of the cylinder acts on the piston *e* instead of piston *f* and this pressure will be reduced in the ratio of the surfaces of the piston *f* and *e*.

For load braking, the layout is the same as for high power braking except that the electrovalve is replaced by a cock. The open position of this cock corresponds to « empty braking » and the closed position to « load braking ».

The changes of working conditions « Passengers — Goods » and « Flat country — Mountainous country » do not exist with the electro-pneumatic brake.

Actually, these working regimes modified the compromises that had to be

made as regards the application and release times as a consequence of the low speed of propagation and the possibility of discharge of the pneumatic brake. As these defects no longer exist with the electro-pneumatic brake, this brake can be used for « Passenger », « Goods », « Level country » and « Mountain country » regimes without any alteration in the settings.

The electric control is designed in such a way that any defect in its working acts in the direction of safety. In fact, all the electrovalves have to be energised to release the brake.

The electrovalves employed have to control the pressure in the relatively small air chambers of the regulator and can be designed to function in complete safety even if the voltage of the current supply falls.

It is to be noted that the source of current exists on the locomotive alone. This supply which has to feed four electrovalves per vehicle when releasing, must be sufficient in capacity for releasing the brakes of very long trains. On electric or Diesel-electric locomotives, a battery will supply the energy needed readily seeing that means for recharging it even when standing are available.

This high power is only needed for very long goods trains. These trains have to be hauled by very powerful locomotives. It is only therefore on these very powerful electric locomotives that provision has to be made for a relatively great supply of current for the electro-pneumatic brake.

On locomotives of medium power, the supply of current would be normal; in double heading when hauling very long trains, the supplies of current from the two locomotives can be added together.

Similarly, the return current circuit through which passes the current from all the electro-valves has to be of heavy section to enable long trains to be operated. This difficulty can be overcome by allowing the return current to pass through the framework and wheels of the vehicles and by the rails back to the locomotive.

It must be noted that the system described can give rise to certain difficulties when used with certain distributors the accelerators of which are operated by the difference in pressure between the train pipe and the control reservoir. Actually, after brake applications, the momentary reduction of pressure in the auxiliary reservoir and consequently in the train pipe can set in operation the accelerator of these distributors and this could adversely affect the flexibility of braking and would certainly cause a useless consumption of compressed air.

If it is essential to retain these distributors, as for example when adding the electro-pneumatic brake to existing vehicles with compressed air braking, it would become necessary to provide a lock on the accelerator or block it.

To sum up, the inherent advantages in the electro-pneumatic brake may be enumerated as follows :

— The speed of propagation is infinite and this results in great steadiness in braking and enables very long trains to be operated.

— The time of application of the brake can be reduced to 1 to 2 seconds on passenger trains as well as on goods trains, and this allows the train speeds to be increased.

We may remember that with modern pneumatic distributors, the brake application time is set at 3 to 6 sec in passenger service and 20 to 28 sec in goods working.

— The release times too can be reduced to equally low values seeing that the auxiliary reservoir is recharged during braking and consequently the system is practically perfectly inexhaustible.

— These times with modern distributors are 15 to 20 sec in passenger working and 45 to 60 sec in goods.

— Over-recharging cannot occur any longer.

— The control of the brake is very flexible and the staff require no longer instruction in its use.

— Changes in operating regime, such as « Passenger », « Goods », « Level » and « Mountainous » do not have to be made.

In conclusion, we may point out that after a transition period when most vehicles are equipped with electro-pneumatic brakes, the air brake can be given up. The pneumatic distributor and its auxiliary reservoir would be replaced by a simple valve which would put the auxiliary reservoir in communication with the cylinder when the pressure fell too much in the train pipe.

[347 .763 .4 (494)]

The scope of the new Swiss law on the railways,

by A. PAILLARD,

Assistant General Secretary to the Swiss Federal Railways, Berne.

On the 20th December 1957, the Parliament of the Swiss Confederation passed a new law on the railways, which had received 145 votes in the National Council and 33 votes in the States Council, without opposition. Such unanimity was all the more remarkable seeing that the legislators were faced with a problem bristling with difficulties. When the question was first debated, M. LEPORI, Federal Counsellor, reminded the National Council that the new statute had to harmonise the interests of the State, the general economy and the railway. The absence of any opposition in an assembly which reflects the multiple differences of opinion of a very heterogeneous country permits us to think that this objective has been attained.

The work in parliament having been completed, the new law came into force on the 1st July 1958, so that it may be of interest to study the motives for this revision, its essential points and its repercussions.

1. The motives for revising the legislation.

The previous law on the railways dated from 1872. This replaced that of 1852 on the establishment and operation of railways — the first of its kind — compared with which the chief change was the transfer to the Confederation of the sovereignty in the railways till then held by the Cantons. From 1872, every effort was made to achieve the indispensable unity of jurisdiction. Between 1873 and 1902, no fewer than 23 laws and 12 Federal decrees were issued and 20 international treaties were ratified. In 1902, the Swiss Federal Railways inaugurated their activities. From this date, legislative output evolved at a somewhat calmer pace, although a great deal still remained to be done. Until the 30th June 1958, the whole edifice still rested upon the foundations laid in 1872.

It was not surprising therefore that a law which was nearly 90 years old no longer met present requirements. Since 1872, a great many changes had occurred in the transport field, but already at that time it was appreciated that the railway would give a considerable impetus to the economic life of the regions it served. As no competitor was to be feared in the case of overland communications, the legislator thought he could treat the new method of locomotion as an instrument of the economic and defensive policy of the State. Since the railway already enjoyed a monopoly, which to all appearances would increase as time went on, there was no hesitation in imposing the most diverse obligations upon it. The railways from then on had to carry out military transport at half price, carry letters and parcels free, pro-

vide the post office with suitable premises in the stations rent free, allow telegraph lines to be set up alongside the permanent way, as well as to support without compensation any inconvenience caused by the construction of roads, highways, water mains, etc., across their property. In addition, they had to accept continuous supervision of their tariffs, i.e. their prices. And these are only a few examples. The future of the new undertakings seemed so rosy that the legislator required them to make a payment of an annual concession fee of 50 francs per kilometre of line in operation when the profit shown by the operating account amounted to 4 %, after deducting the amortisation charges or sums allocated to the reserve fund. If the profit was higher, this payment might rise to as much as 200 fr.

Many of these hopes were doomed to disappointment. The railways did not bring wealth to their owners. At the present time, the private concerns are not the only ones : since 1902 a great part of the Swiss system has been nationalised. There is no longer any question of a transport monopoly since a very lively competitor made its appearance on the roads. The law of 1872 nevertheless has remained in force right until now, many out-of-date clauses being altered over the years by a more reasonable interpretation, as for example with regard to relations with the Post Office. Alterations in the economic structure however made it necessary to postulate a revision of the whole legal basis. Consequently, it was necessary to revise the whole legislation, not only by abrogating several laws and decrees, but by regrouping, as had long been recognised as desirable, those texts which should continue to regulate railway activities.

2. The essential characteristics of the new law and the innovations introduced.

It was necessary to determine to begin with the *field of application* of the future statute. The law of 1872 gave no definition of a railway. The new text lays down that these are : « undertakings which are of intention available to everyone for the transport of persons and goods, whose vehicles run on or under rails ». The telpher railways are not included with the railways any more than the trolleybuses, although the question was gone into at length as to whether these latter should not come under the new law. On the other hand, suspended railways (which move under rails thanks to some form of suspension) are included should any such ever make their appearance in Switzerland.

Then, there was the problem of *main lines* and *secondary lines*. The conceded undertakings asked for this distinction to be removed, but the legislator was not able to meet them on this point, so that, according to the new law, main line railways are those standard gauge railways carrying national and international traffic in transit, whereas secondary railways are those standard gauge railways essentially concerned with the traffic of a given region, as well as all narrow gauge lines, rack railways, tramways and funiculars. This differentiation is in fact not only theoretical, since the secondary undertakings enjoy va-

rious facilities, for example as regards closing down lines, technical equipment and compensation for junctions.

As the great period of railway construction may be considered to have come to an end, the clauses relating to the granting of concessions for new lines have lost some of their importance. In spite of a certain amount of opposition, the granting and renewing of concessions remains the attribute of the Federal Assembly, but the Federal Council is competent to make any changes dictated by circumstances, after obtaining the agreement of the Cantons. Thus, it can authorise the suppression of the concession of a secondary railway when the use of other methods of transport is proposed, which is a matter for congratulations. Another wide reaching clause, which is assuredly justified from the organic point of view, states that a concession can only be granted to build and operate a railway line when the traffic cannot be better assured by any other means. The object in view will not be achieved however unless all the circumstances are taken into consideration objectively without any preconceived ideas.

The new text clearly states that the holder of the concession has not only the right but also the obligation to build and operate the railway line. This does away with an element of uncertainty in the old law. In addition, the holder of the concession is expressly forbidden to contract out of the obligations imposed on him and the rights given him by the law and the concession.

In our days, as in the past, the construction and operation of railways is a matter of interest for the community as a whole which justifies the *Confederation controlling* such undertakings. The central government is however always able to restrict such control should it consider it advisable to do so in order to assure the rational functioning of the administration. In order to facilitate such supervision, foreign administrations and undertakings operating a railway in Switzerland are asked to appoint a representative permanently domiciled in Switzerland; the Confederation, Cantons and other Public Authorities who have granted important subsidies or loans are entitled on their side to be represented upon the railway administration in question.

The chapter dealing with the *construction and operation of railways* is very important. A first regulation lays down that the railway installations and rolling stock shall be built, maintained and renewed in conformity with the requirements of the traffic and technical progress. The undertakings must be run and administered as far as possible on uniform lines. Whence their obligation to have up to date rolling stock and to have a sinking fund to allow of its renewal. Building projects of any third party likely to affect railway property or the safety of the latter will come under the supervising authority, which was not the case before.

The most striking and decisive innovations of this part of the law deal with the distribution of costs, in connection with which the logical conclusions to be drawn from the profound changes that have come to pass in the structure of transport have been taken into account.

In the case of safety measures, the railway in future will only have to bear the cost of its own work. When such measures are necessitated by work undertaken by third parties or have to be undertaken because of them, the third parties in question must bear the cost. When it is question of making a crossing between a new railway line used for public traffic and a public highway, or between a new public highway and the railway, the owner of the new line or road pays for all the crossing installations, but the use of the road or railway territory must be granted free of charge. If a level crossing has to be replaced by an over or under bridge, or done away with owing to the rerouting of the road, the cost of all the modifications to the railway and road installations is to be borne by the railway if its own traffic requirements are the essential reason for the modification. On the other hand, the highway authorities will be responsible if the modifications are due to road traffic requirements. In the case of all other modifications affecting a crossing, including the adaptation and perfecting of the safety installations, the railway and highway authorities will divide up the cost of the whole of the modifications made to the railway and road installations in the proportion to which they are required because of traffic developments on one or the other. Each party must however always contribute in proportion to the advantages they will obtain from the alteration, but the party insisting upon any special requirements will bear the whole cost thereof. These regulations apply by analogy to crossings with private railways, public or private waterways, transmission or telpher installations, mains and other similar works.

The rules of the old right which excluded any indemnity for any infringements of railway rights at crossings therefore no longer apply. In future, both lines of communication are upon an equal footing. The allocation of the cost according to the principle of causality is the logical consequence of the evolution of road traffic. It is certainly equitable to make each method of communication pay for modifications according to the extent to which it profits therefrom or else to chalk them up to the party responsible for them. But, taking the advantages obtained as the basis appears to be equally just : in any case, when level crossings are suppressed, the railway undertakings already are accustomed to pay a contribution which may amount to the capital sum represented by the definite saving on not having to have a keeper. It is this same principle of causality which is used as a basis when asking the party interested in the free flow of traffic to share in the costs involved when it involves the railway in commitments it is not reasonable to expect it to bear by itself.

Up till now, in the interest of the community, the railways have had to support numerous charges for which they have received little or nothing. The clauses devoted to *special charges in favour of public administrations* puts an end to this system. In the opinion of the Federal Council, railway undertakings should be compensated for such charges, in order to obtain a correct division of the charges in the accounts of

these undertakings and those of the public administrations. Compensation will therefore be calculated according to the principles admitted in commerce, whether they fall upon the Confederation, the cantons, the communes, other public corporations, their establishments or their services. If the government requires the railway installations and rolling stock to be built, completed and held ready for service in conformity with the requirements of the national military and economic defence, the federal funds must stand the cost of the necessary measures. naturally taking into account the advantages which the undertaking itself will reap. The railways are still obliged to carry out military transport, but the law no longer obliges them to do so at half price. In principle, their obligations towards the Post Office, Customs and Public Health Services should also be covered by an equitable charge, i.e. one that covers the cost thereof, as well as the interest and sinking fund charges on the capital invested in the special installations.

The chapter dealing with *obligations imposed in favour of the general economy* and with *charges extraneous to the operating* marks a further stage in this direction. In effect, it requires the Confederation to indemnify the Swiss main line railways for any financial difficulties caused by obligations imposed in favour of the general economy and extraneous charges. The said obligations are a corollary of the fundamental obligations which give the railway its character of a public service (obligation to operate, to observe set timetables, obligation to carry, to apply fixed tariffs), as well as tariff and operating regulations which are closely linked up with economic, social and cultural requirements. It also covers any obligations which an undertaking organised on commercial principles would never accept without due compensation. The extraneous charges are those charges which have no direct connection with the duties of the railway in its role of public transport service.

It appeared impossible to obtain an exact estimate of the proper compensation for the obligations assumed in the general economic interests. The various obligations are a fact, and they undoubtedly hinder the freedom of action of the Railway Administrations. But it is not possible to set a definite monetary value on the inconvenience caused. Consequently, after much discussion, the legislator pronounced in favour of an overall compensation which in the case of the private railways corresponds to one third of the prescribed sinking fund. In the case of the Federal Railways, it will be fixed by a simple Federal decree. The extraneous charges on the other hand can be determined. The compensation to be paid for these, both to the Federal Railways and the private railways will be based on the accountancy results.

The laws of 1939 and 1949 on assisting the private railways, the period of validity of which was limited, already included clauses concerning the *development of the railways and measures of assistance.* The fundamental principles laid down at that time concerning the aid to be given to the private railways have once more been adopted, so that

the Confederation is authorised to grant subsidies and loans to railway undertakings which are important factors in the general traffic of the country or of one of its regions, in order to enable them to establish or complete their installations, or again to purchase rolling stock if this would enable the lines to be run in an appreciably more economic fashion or with greater safety. For example by this means the change-over to a different method of traction can be facilitated, or the adaptation or suppression of level crossings and the improvement of junctions. In addition, it is possible to encourage the organisation of road services doubling or replacing the railway when by this means the traffic can be carried as well as in the past. Finally, the Central State has the faculty of assisting the railways which are in debt to remain in operation as long as they are indispensable to the general traffic of the country or one of its regions, but no similar provisions are made for the Federal Railways. All interventions by the Confederation are subordinated to the financial participation of the cantons, which must amount to a suitable sum, or in certain cases to half the amount of the Federal subsidy. In exceptional cases, the contribution from the Canton can be reduced according to the financial position of the Cantons concerned. This allocation of the costs gave rise to lengthy discussions. It was even one of the few points on which the two legislative councils had great difficulty in coming to an agreement.

The deputies caused a clause to be inserted in the law which made it possible to take legal steps to introduce measures *to alter the railway tariffs* when the needs of the country or one of its regions justified such a step. In this respect, they were thinking in particular of a reduction in the tariffs of the Rhaetian Railways which belong to the Canton of Grisons. The delegate for economic affairs of the Post Office and Railway Department has begun the preparatory work involved, in close collaboration with the tariff department of the Federal Transport Office.

The other chapters — accountancy methods, buying out, relief funds, penal clauses and administrative measures, temporary and final measures — are based essentially upon the old law. As far as taking over by the Confederation is concerned, should it be considered that this is necessary in the national interest, the method of calculating the indemnity to be paid has been clearly laid down : in future, it will depend upon the commercial value of the railway and the value of the railway installations. The commercial value is calculated on the basis of the probable return to the purchaser, taking into account all the advantages and disadvantages this will bring him. The purchase price must not however exceed the value shown on the balance sheet, which is based on the cost of construction or purchase of the installations from which sum is deducted the prescribed sinking fund moneys.

3. The repercussions of the new law.

As we have seen, the railway statute of 1872 was based on the fact that the railways enjoyed a monopoly in fact in the field of transport. They were therefore made to serve various ends as regards the general, economic and military policy, without bothering about the

financial repercussions. As a result, they were subjected to many obligations based on social considerations or the internal colonisation policy of the country. As long as they actually had a monopoly, this situation was not intolerable. But this was no longer the case when road vehicles began to compete ever more seriously against the railway and were exempt from any of the burdens from which the railways suffered. Because this competition was not recognised at first, then under-estimated and finally overlooked because of other problems which attracted greater attention, the public authorities found it necessary some twelve years ago to restore the financies of the Federal Railways, whilst the competition from untold private undertakings continued to increase.

Now that the law has recognised the new circumstances and freed the private railways from most of the obligations imposed on them without any compensation, it is to be hoped that their financial position will become sounder. As a consequence, the cantons which assume in one way or another the responsibility for meeting the deficits of such undertakings, will have less to meet.

The case of the nationalised system is somewhat different. This will assuredly benefit up to a certain extent from the new way of distributing the costs, but the compensation to be paid for its obligations in favour of the general economy still has to be decided. Likewise it will not be assisted to improve its technical installations, whereas this question has already been settled in the case of the private railways. The law however authorises the Confederation to come to its assistance should this be necessary. For the moment it is hoped that this will not be necessary and it remains subject to the law on the Federal Railways of the 23rd June 1944 (1) which has not been revoked by the law with which we are now dealing.

Economists can but congratulate themselves upon the new railway statute. It is assuredly more rational to compensate the railways for their obligations than to subsidise them at the expense of the public authorities. The financial obligations imposed on the Confederation by the new law must not however be minimised. According to the declarations made by M. Lepori, Federal Councillor, at the autum 1957 Session of the Chambers, the cost will probably amount to 26 or 27 million francs a year, i.e. 6 to 7 million francs for the obligatory services rendered by the railways in favour of the general economy, 11 million francs for costs born by the Federal Railways which are extraneous to their operating, 6 million francs for technical improvements to the private railways and 3 million francs for keeping certain of them in operation, including changing the

(1) The law on the Federal Railways of the 23rd June 1944 which has been in force since the 1st January 1946 wiped out the deficit of 900 million francs from the balance sheet of the C.F.F. and gave them a capital of 400 million francs. It laid down that the C.F.F. are run in the interests of the national economy and national defence, although they are administered and operated on sound economic principles. They must be constantly maintained in a good state of repair and adapted to traffic requirements and technical needs. This law fixes, in addition, the attributes of the Federal Assembly, the Federal Council, the Administrative Council and the management as regards the management and financial regime of the C.F.F.

method of traction. Apart from these two latter cases, these allocations can in no wise be regarded as subsidies. They are amounts lawfully due, which would be claimed by any private undertaking in a similar situation, and which it could not reasonably be expected to forego.

Experience during the last decades has shown to what an extent a modern railway system is essential to the life of a nation. All the neighbouring countries around Switzerland are working to improve theirs. The Swiss Railways also must follow the progress of the technique as long as they cannot be replaced by an other method of transport. This necessity is generally recognised. A freer hand from the Treasury would enable the undertakings to increase their productivity. The resulting reduction in costs would profit the national economy, as this is in fact the only way of stemming, at least to some extent, the constant increase in labour costs.

The new law in no way modifies the character of public service of the railways. It stresses somewhat more clearly the commercial aspect of the problem, but the fundamental obligations of these undertakings are retained, and in this connection, no compensation is provided for the Federal Railways. Consequently, this Administration cannot itself suppress any lines showing a deficit (obligation to operate); given places must be served at previously determined hours, until the end of the period for which the current timetables are valid, even when there are very few passengers (obligation to respect the timetables); the railways are in principle bound to accept the transport of all passengers and goods they are asked to carry (obligation to transport); in addition, they must apply standard tariffs to each passenger and each consignment of goods which cannot vary from one case to another according to the costs or conditions of competition (obligation to apply the tariffs uniformly to all persons complying with the conditions). In this connection, in spite of the new law, all transport undertakings cannot meet competition on equal terms. The railways must however endeavour to adapt themselves to this situation, although it prevents them from having a sufficiently flexible commercial policy.

One may, in good faith, question the advisability of such and such a clause of the new railway statute. In the presence of such a vast undertaking, such a reaction is only human. Nevertheless, taken as a whole, the new law will be in the interests of the country and the populace, but it must not be expected to work miracles, nor need we succumb to the illusion that the railways are about to enter upon a golden age. The immensely important problem of the co-ordination of methods of transport has not yet been solved. Competition from the road is becoming increasingly severe. Therefore, the railways in general, and the private railways in particular, should continue to make every effort and take every possible technical and economic step constantly to improve their transport capacity and obtain the maximum output. In this connection, the new law will put them on a more secure footing, and their efforts, seconded by the authorities, will have the approbation of all those who make use of the railway.

[656 .25 (42)]

Automatic setting of junctions by programme machine on the Underground Railways of London,

by R. Dell, O.B.E., M.I.E.E., M.I. MECH. E., M.I.R.S.E.
Signal Engineer, London Transport Executive.

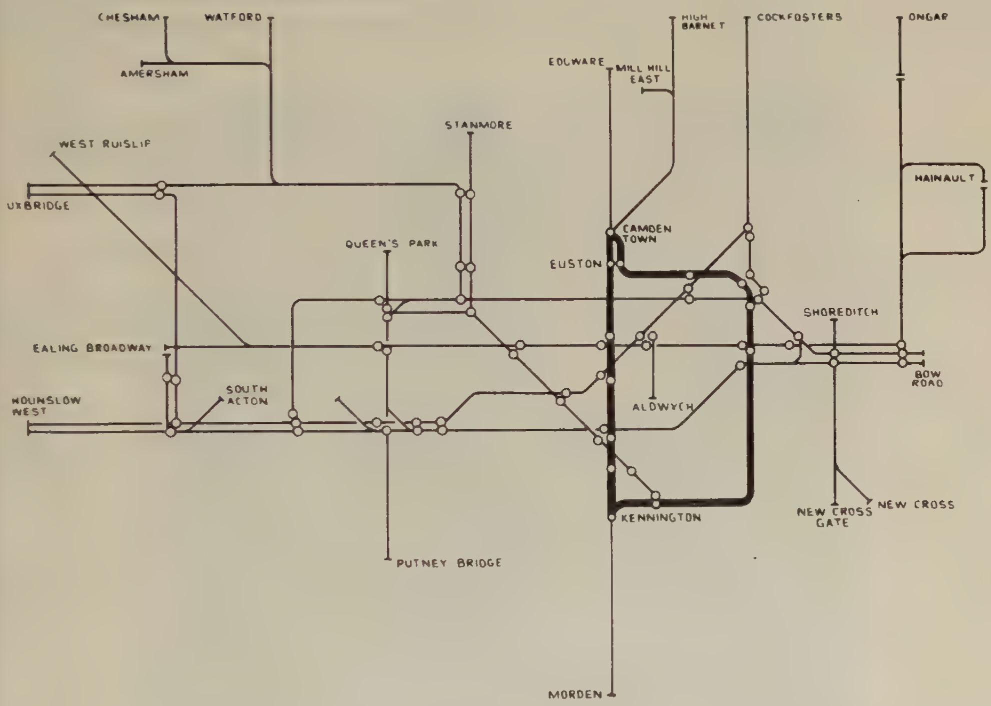


Fig. 1. — Diagram of London Underground Railways showing in thick lines the section of line with automatic junction working controlled by programme machine.

During 1958, a new system of automatic control of junctions by programme machine has been installed on one of the tube railways of the London Underground system, the Northern Line being chosen for the initial application of this system.

The Northern Line is one of the most complicated of the tube lines, having junctions North and South of the centre of London.

On the map of the London Underground Railways (fig. 1), the section of line on which the programme machine

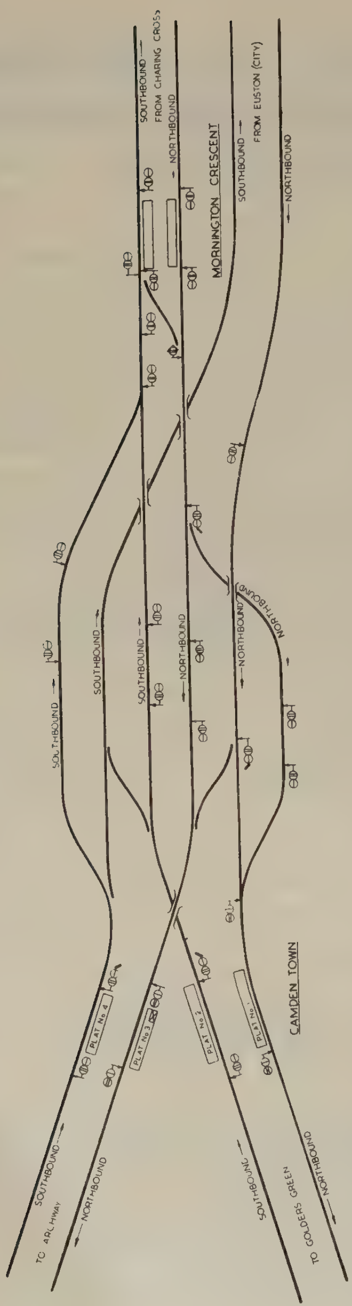


Fig. 2. — Junctions at Camden Town, where two double-track branches meet and provide interconnection.

route setting has been installed is shown in heavy lines. The junctions so controlled are at Camden Town, Euston and Kennington. A detailed plan of the junctions at Camden Town is shown in figure 2 and of Euston in figure 3, and the junctions at Kennington are shown in figure 9. All these junctions are operated by programme machines, so that the whole of this central section of the line will operate automatically, without signalmen.

The service of this section of line amounts to 650 trains per day, in each direction of the four tracks.

Existing train describers.

The line is already equipped with train describers, which give information to the passengers of the destination of the train and similar information to signalmen at junctions. The particulars of the destination of the train or train description is transmitted by the signalman at the terminus of the line, as each train leaves. This is in the form of a code transmitted over four wires. The code is stored in receivers at each station and signal cabin, until the arrival of the particular train. The storage is in the form of an electromechanical drum, which can store up to 32 descriptions, each of which can be one of 15 destinations.

The working of this existing train description has been incorporated in the new programme machine operation.

Interlocking machines.

London Transport employ, as a standard in all their new signalling installations, interlocking machines for the

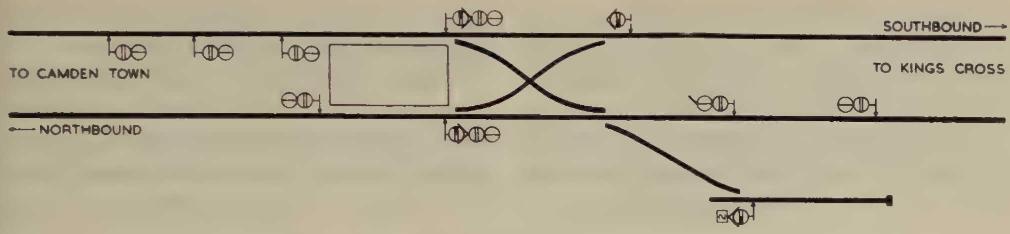


Fig. 3. — Track layout at Euston, where programme machine working provides for through movements as well as reversal of trains.

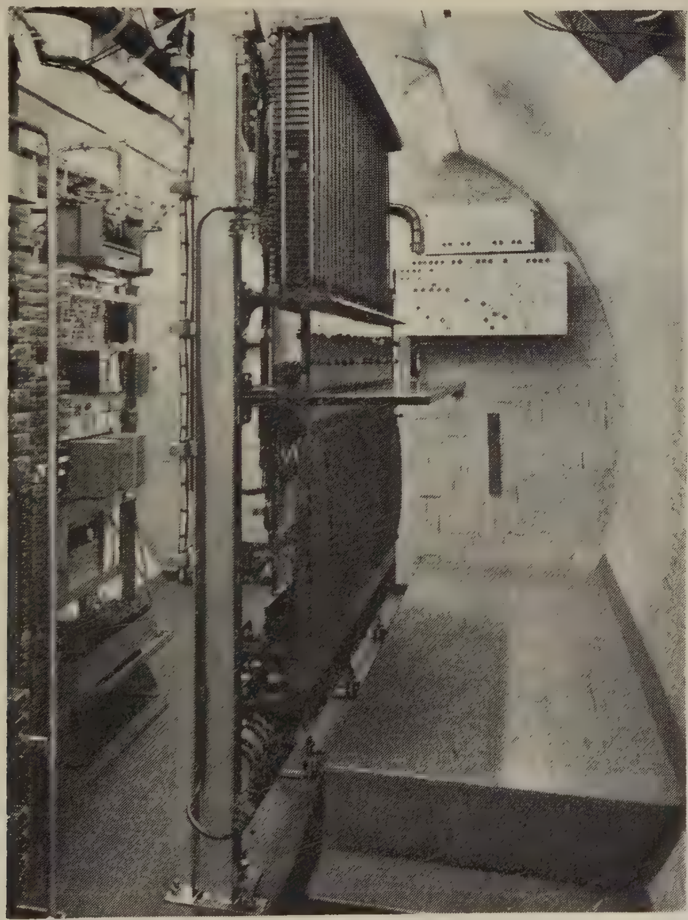


Fig. 4. — Interlocking machine installed at Kennington and controlled from the programme machines.

signalling proper. These are electro-pneumatically operated and have mechanical interlocking, and take care of all the safety features of the signalling. These interlocking machines were designed for push button working, but they are also used in the programme machine working and enable the complicated electrical circuits to be added to the signalling circuits, without impairing in any way the intrinsic safety of the signalling installation, although the programme machine circuits employ only small relays of the telephone type and small wire with thin insulation.

Figure 4 shows one of these interlocking machines, which is operated from the programme machine. It comprises a series of vertical shafts, each one of which is rotated through an angle of 60° by means of two small compressed air cylinders mounted at the bottom of the machine. The electro-pneumatic valves for these cylinders are actuated from the programme machine circuits. Mechanical interlocking is provided be-

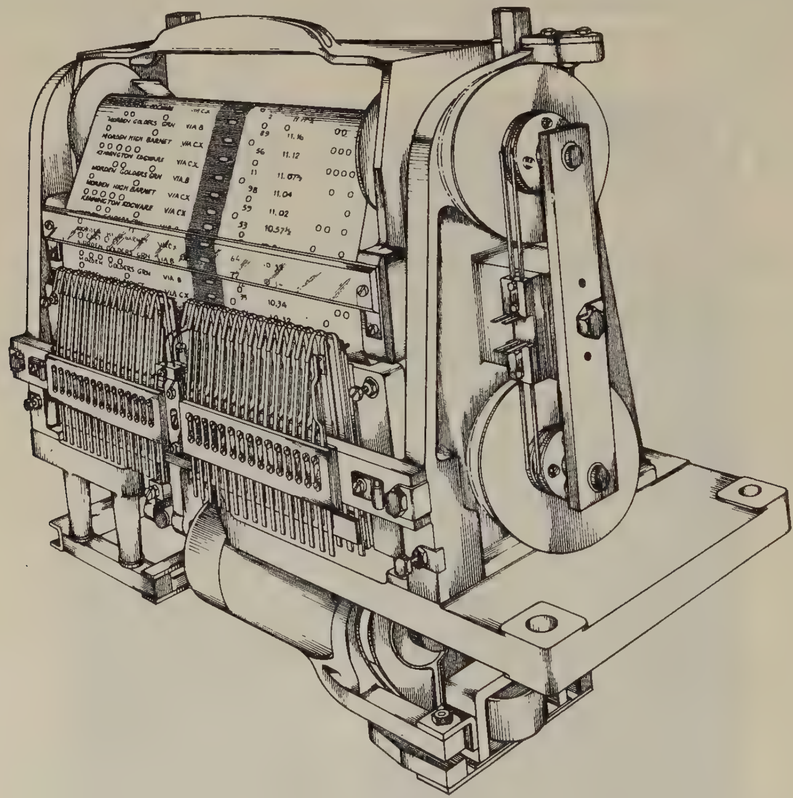


Fig. 5. — Perspective drawing of programme machine.

tween the shafts and this can be seen in the illustration. An electric lock is also provided to each shaft for approach locking and back locking purposes. The shaft is provided with a number of contacts from which the signalling circuits proper originate.

Programme machine.

The programme machine has been designed to carry the particulars for each train on the time table for the whole day. The programme itself comprises a roll of plastic material, 20 cm wide,

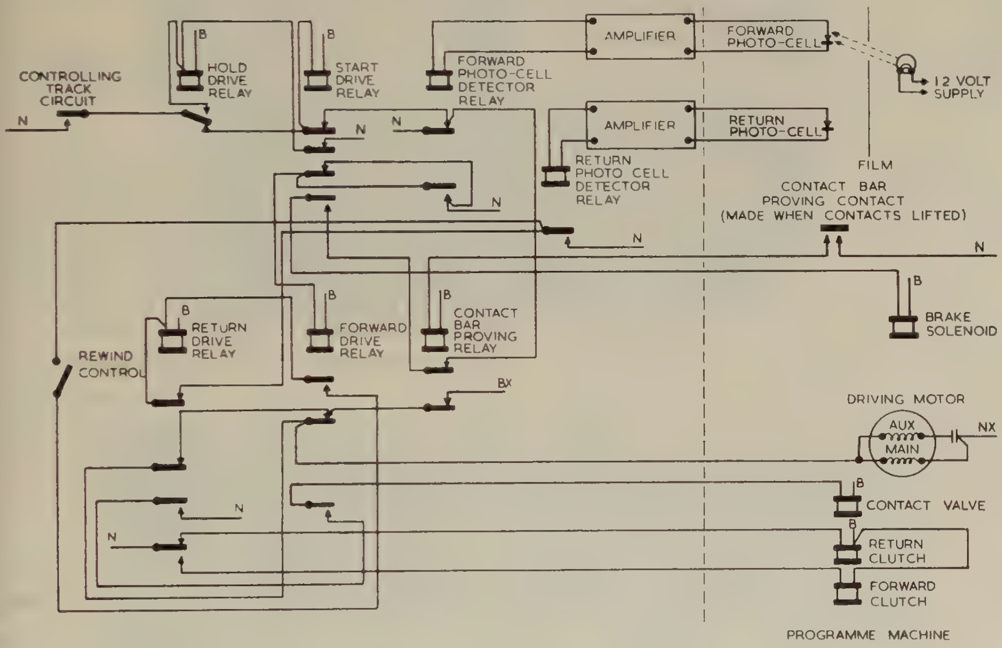


Fig. 6. — Electrical circuit associated with the programme machine for the movement of the programme roll.

These interlocking machines have a separate shaft for each signal or pair of points, and thus the actual signal and point circuits are kept simple.

The operating circuits to the electro-pneumatic cylinders of the shafts are arranged on the route principle and operate the appropriate number of point and signal shafts for setting a complete route.

and the information for each train is in the form of a row of punched holes across the roll. A total of 30 holes can be provided in each row. The programme roll is mounted on two rollers and is driven by a small electric motor through magnetic clutches, so that the roll can be moved in either direction. A magnetically operated friction brake

enables the roll to be stopped in the required position.

Figure 5 shows a perspective view of the complete programme machine.

The holes punched in the programme roll are read by the machine by means of a series of feelers which actuate contacts. These feelers are pressed on the surface of the roll, and where the feeler enters a hole in the roll, the contact is closed. Where there is no hole in the roll, the contacts are kept open.

The details of the train are typed on the surface of the roll, so that full information is available when setting the roll and also when the repeater roll is observed in the supervision room.

The movement of the roll from one row of holes to the next is governed by a photo-cell working on a special line of holes near the centre of the roll, and the operation is — that for each movement of the roll, the feelers are withdrawn, the magnetic clutch engaged and the roll moves forward one line until the photo-cell is illuminated by the next hole in the roll permitting light from the lamp to strike it. The circuits are then arranged to stop the motor and apply a brake, holding the roll in its new position, when the feelers are again pressed on the surface and the contacts read the punchings provided. At the end of the day's service, the machine automatically re-rolls to the beginning, ready for the next day's operation. The re-rolling process is governed by a second photo-cell.

The electric circuit for the drive of the programme machine is shown in figure 6.

The programme machines and the associated electrical circuits are arranged to perform the following functions :

1) signal all the trains over the correct routes, in accordance with the time table;

2) check the time of all trains and sound an alarm, if any train is more than two minutes late;

3) check the train description on the train describer and ensure that it agrees with the time table;

4) if trains are late on one branch and trains are waiting on the other branch of a line, to signal the waiting train out of turn and store information of the delayed trains, which are automatically signalled when they appear.

Each programme roll is mounted on a detachable carrier, so that separate programmes can be inserted for week day or Sunday services.

Figure 7 shows a programme roll on its detachable carrier.

Central supervision room.

A central supervision room is provided at Leicester Square, which is approximately at the centre of the line. A man in this room can supervise the working of all the programme machines and deal with some special happening, such as the cancellation of a train. This room is equipped with repeater programme machines and an illuminated diagram of the track.

Figure 8 shows a photograph of this room.

Switches are provided on each of the programme machine panels, so that the

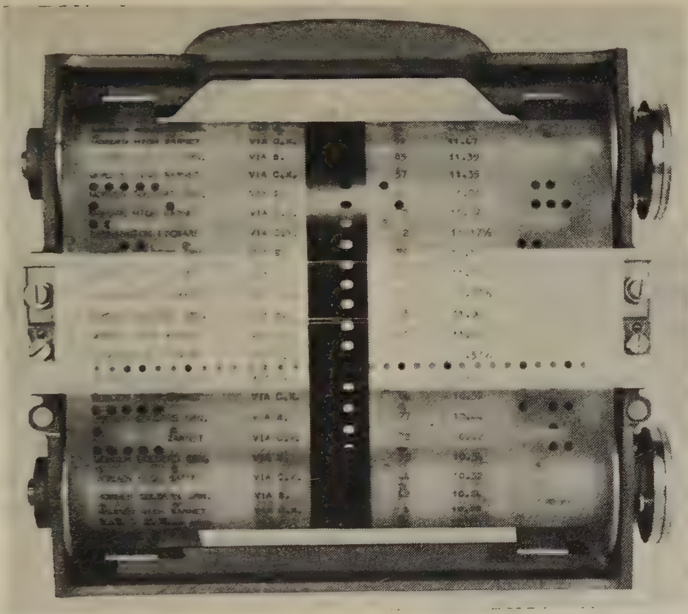


Fig. 7. — Programme roll on its carrier, removed from programme machine.

Fig. 8. — Central supervision room for automatic junction working, Leicester Square, London Transport.

junctions can be switched to one of three conditions :

1) programme machine working;

2) « first come, first served » working;

3) push button control from the central supervision room.

Alarms are provided, which sound to draw the operator's attention :

1) if trains are more than two minutes late;

2) if the train describer disagrees with the programme machine;

3) if the programme machine has routed a train out of turn.

Provision is made for the possible cancellation of trains on the programme and this is in the form of a row of push buttons with corresponding indicating lamps. The method of cancelling a train is that the operator, when he receives information by telephone that a particular train has been cancelled, by looking at the typescript on the repeater programme machine for the particular junction concerned, can see, for example, that the train is the third one to pass over the junction. He then presses cancel button No. 3, and the equipment counts the trains as they pass, until the second train has passed, when it automatically causes the machine to step twice, so that the train cancelled is passed over on the programme.

Use of programme machine to indicate time.

The programme machine actually setting the route over junctions must wait for the actual appearance of the train on the programme and deal with it, whether it be early or late. This machine is therefore arranged to step its programme forward only for the passage of a train. This is called sequence machine working. A second machine is, however, employed at each junction and is arranged to provide a reference to the time of day. This machine, which is identical in design with the sequence machine, is arranged to be stepped by half-minute impulses from a master clock. The information of the time between two successive trains is punched on the machine's own programme roll in the form of a binary number indicating the number of half-minutes. A counter then counts the half-minute impulses received from the clock, and when the number of impulses received corresponds with the binary number punched on the roll, the drive circuit for the machine is energised and steps the machine forward once.

The sequence machine and the time controlled machine are interconnected by means of a coincidence circuit actuated from a code of four holes punched on each of the rolls. When the two rolls are in step, the coincidence circuit is completed and indicates this condition.

Throughout most of the day, the sequence machine will be one step ahead of the time machine, and it is when the time machine catches up with the sequence machine that the coincidence circuits indicate that it is now time for the train shown on the programme.

This time information is used to actuate the late alarm. It also initiates the circuit for out of turn working and,

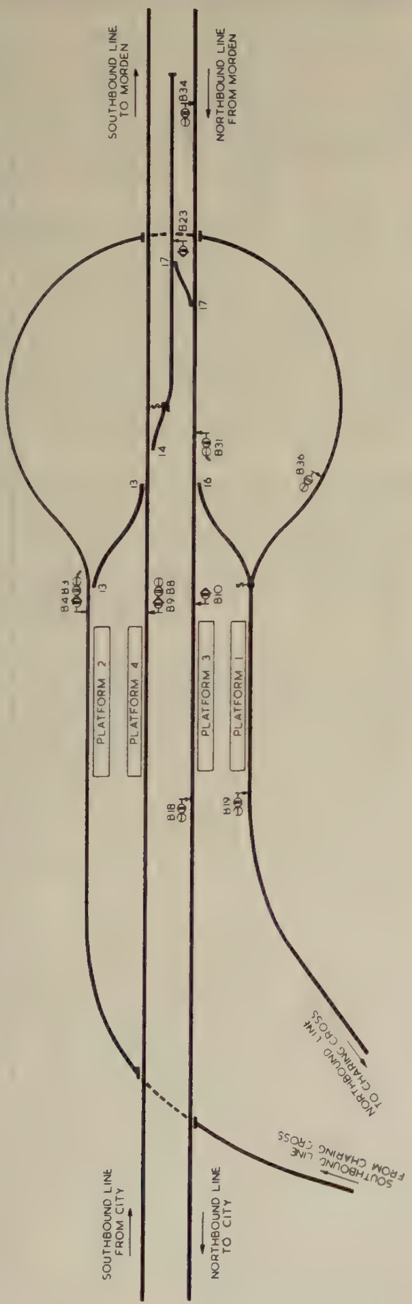


Fig. 9. — Plan of the junctions at Kennington.

in some instances, is arranged to hold signals at danger until it is time for the train to depart.

Checking of the train describer.

In addition to the information regarding the routeing of the train punched on the programme roll, the destination of each train is also shown by the punchings of a 4-hole code, this code agreeing with the code used on the train describer.

Circuits are arranged, so that each train on the programme automatically checks with the train description of the next train, as shown on the train describer, and provided that they are in agreement, the programme machine circuits complete the routeing of the train. If, however, there should be a discrepancy between the destination of the train as shown on the train describer and as shown on the programme, the routeing of the train is delayed for one minute, and meanwhile an alarm is sounded at the central supervision room. If the operator at the central supervision room takes no action on hearing the alarm, at the end of the one minute, the programme machine circuits will proceed to route the train in accordance with the train description, and not in accordance with the programme. If, however, the operator at the central supervision room has received advice that a train has been incorrectly described on the train describer, when he hears the alarm sound, by pressing an acknowledging button, the programme machine will proceed to route the train in accordance with the route shown on the programme.

Route	Route	Set up by	Timed	Train describer check	Permission
3 (1)	Platform 2 to loop	No. 1 sequence machine	no	yes	none
3 (2)	Platform 2 to Morden	No. 1 sequence machine	no	yes	No. 2 sequence machine
4	Platform 2 to siding	No. 1 sequence machine	no	yes	No. 2 sequence machine
8	Platform 4 to Morden	No. 2 sequence machine	no	yes	none
9	Platform 4 to siding	No. 2 sequence machine	no	yes	none
18	Platform 3 to City	No. 3 sequence machine	no	no	none
19	Platform 1 to Charing Cross	No. 4 sequence machine	no	no	none
23	Siding to No. 31 signal	No. 3 sequence machine	yes	no	none
31 (1)	Signal No. 31 to platform 1	No. 3 sequence machine	no	yes	No. 4 sequence machine
31 (2)	Signal No. 31 to platform 3	No. 3 sequence machine	no	yes	none
34	Morden to signal No. 31	No. 3 sequence machine	no	yes	none
36	Loop to platform 1	No. 4 sequence machine	yes	no	none

Fig. 10. — Kennington - Programme machine working - Table of programmed route setting.

Application of programme machines to junctions at Kennington.

Figure 9 shows the layout of the tracks and junctions at Kennington. In operating these junctions, four sequence programme machines are used :

Programme machine No. 1 deals with the facing junction at No. 13 points on the southbound line.

Programme machine No. 2 deals with the converging junction on the southbound line from the City, and also the facing junction at No. 14 points.

Programme machine No. 3 deals with the converging junction formed by No. 17 points from the siding and the main line, and the facing junction at No. 16 points.

Programme machine No. 4 is concerned with the junction from the loop to the main line on the northbound line to Charing Cross.

Two time-controlled machines are required for this layout, one working in conjunction with sequence machines Nos. 1 and 2, and the other working in conjunction with sequence machines Nos. 3 and 4.

Where the route of a particular train passes over a line operated by two different sequence programme machines, agreement between the two machines is provided for before the route is set.

The table (fig. 10), shows the route setting provided for by the machines and the facilities required for the respective routes. These are the normal conditions and represent the normal programme machine working, with the trains all running in order, according to the time table.

The table in figure 11 shows the different conditions which are provided for by the machine, if the trains are not arriving in accordance with the time table order or time.

Operation of programme machine circuits.

Figure 12 shows a functional diagram of the programme machine circuits for machines Nos. 3 and 4, controlling the northbound junctions at Kennington. On this diagram, the normal controls from the programme machine are shown in the heavy lines, whilst the alternative paths arranged to meet variations in the traffic working are shown in the continuous light lines, and the feed back circuits into storage or to control of the programme machine are shown in the dotted lines. From this diagram, the operation of the circuit can be understood.

The first heavy line on the diagram is for the route signalling a train from Morden forward by signal No. 34 up to signal No. 31. The control of this route originates from a hole in the programme roll of programme machine No. 3, and this passes through the coincidence circuits for the check of the train describer, and with a train on the approach track circuit, the route is then set.

The out of turn working associated with this train movement is shown by the thin solid lines, and it will be noted that there is an out of turn path from 23 route, checking that the siding is

Route	Condition for out of turn	Time initiated by	Alternative action	Storage
No. 3 (1) platform 2 to Loop	none			
No. 3 (2) platform 2 to Morden	Train in platform 2 for Morden. No. 2 machine set for train from City which has not arrived.	Time machine and delay circuit.	Clear No. 3 (2) to send train to Morden.	No. 2 machine step.
No. 4 platform 2 to siding	Train in platform 2 for siding. No. 2 machine set for train from City which has not arrived.	Time machine and delay circuit.	Clear No. 4 to send train to siding.	No. 2 machine step.
No. 8 platform 4 to Morden	Train in platform 4 for Morden. No. 2 machine set for train from Charing cross which has not arrived.	Time machine and delay circuit.	Clear No. 8 to send train to Morden.	No. 2 machine step.
No. 9 platform 4 to siding	Train in platform 4 for siding. No. 2 machine set for train from Charing Cross which has not arrived.	Time machine and delay circuit.	Clear No. 9 to send train to siding.	No. 2 machine step.
No. 18 platform 3 to City	none			
No. 19 platform 1 to Charing Cross .	none			
No. 23 siding to No. 31 signal . . .	Train in siding ready to depart. No. 3 machine set for train from Morden which has not arrived.	Time machine and delay circuit.	Clear No. 23 to send train to No. 31 signal.	No. 3 machine step.
No. 34 Morden to No. 31 signal . . .	Train approaching from Morden. No. 3 machine set for train from siding which is not ready.	Time machine and delay circuit.	Clear No. 34 to send train to No. 31 signal.	No. 3 machine step.
No. 31 (1) to platform 1	Train approaching No. 31 signal. No. 4 machine set for train from loop which has not arrived.	Time machine and delay circuit.	Clear No. 31 (1) to send train to platform 1.	No. 4 machine step.
No. 36 loop to platform 1	Train in loop No. 4 machine set for train from No. 31 (1) to platform 1 which has not arrived.	Time machine and delay circuit.	Clear No. 36 to send train to platform 1.	No. 4 machine step.

Fig. 11. — Kennington - Programme machine control of junctions - Table of « out of turn » route setting.

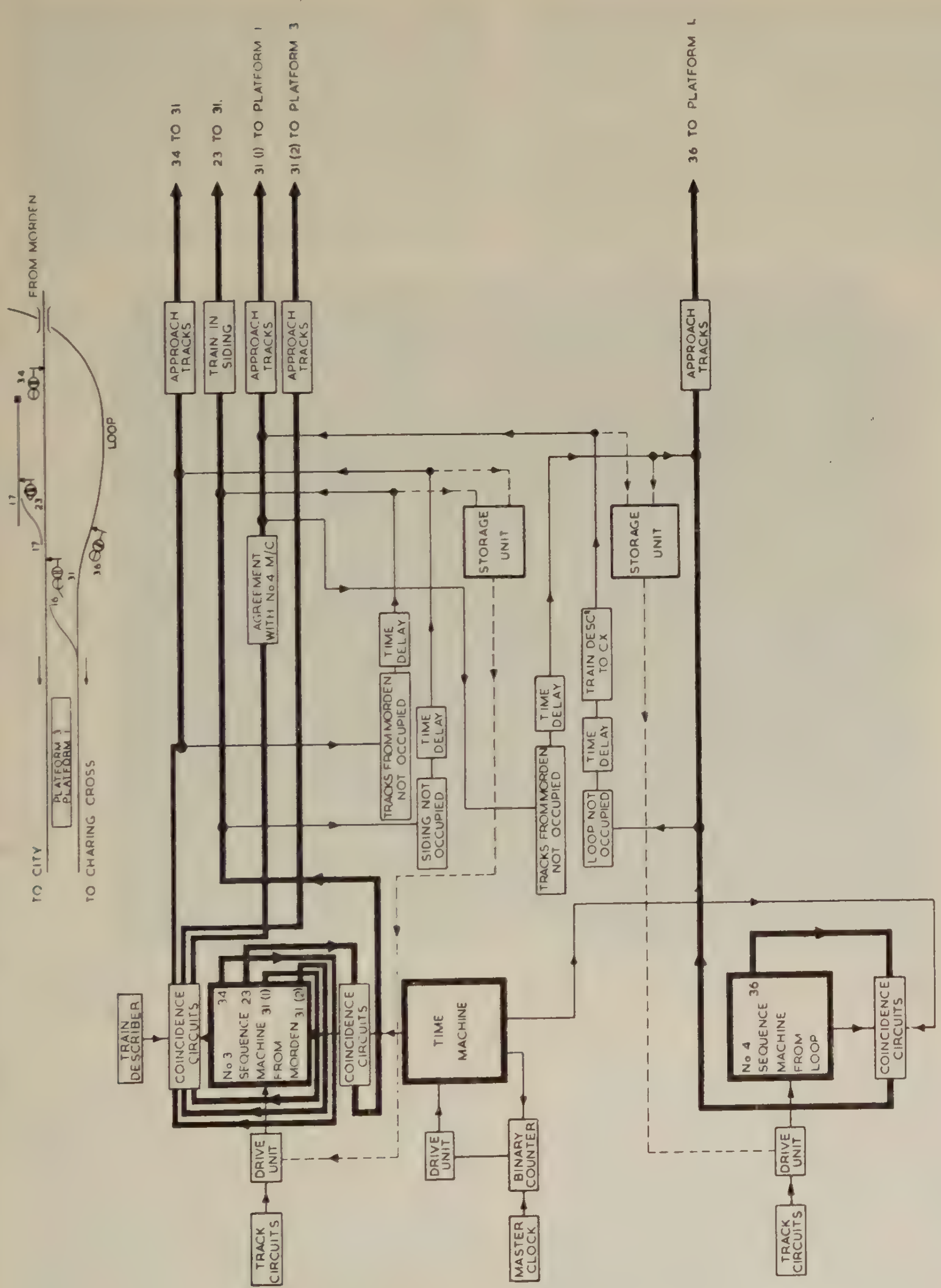


Fig. 12. — Kennington functional diagram of route setting from Nos. 3 and 4 programme machines.

not occupied, and after waiting the time delay, clearing the route for 34 signal, provided that there is a train approaching on this line.

The dotted line shows the path for feed back to the storage unit which, in turn, controls the drive for the sequence machine. The effect of this storage unit in store. When the delayed train does arrive, the programme machine has been waiting for it and is still reading the particulars of its routeing. The passage of this train, which is in accordance with the route shown on the programme, causes the programme machine to step once in the usual way. The storage unit

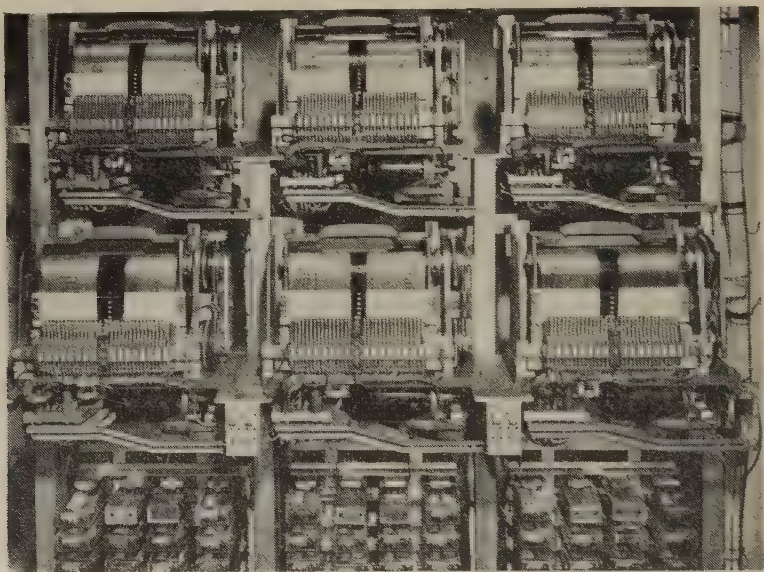


Fig. 13. — Programme machines operating the junctions at Kennington.

is to keep the programme machine in step with the service, when the service returns to the correct order.

The fact that a train has been signalled out of turn, due to the non-arrival of the train programmed, causes the storage unit to hold up the stepping of the sequence machine, so that the sequence machine continues to wait for the train that has not arrived. If more trains are signalled out of turn, the storage unit counts these trains and keeps the number then causes the machine to step additional steps, in accordance with the number of trains stored, bringing the machine back into step with the service.

The rest of the paths for this part of the layout at Kennington can be followed on the diagram in the same way. The heavy lines on the diagram indicate the path for setting the normal route from the programme, the thin solid lines indicate the path for the control of routes for out of turn working, and the dotted

lines feed back into storage. Where reference to time is required, the line is shown originating from the programme machine and passing through the coincidence circuits with the time machine. Where a check of the train describer is required, the path passes through the coincidence circuits with the train describer.

installation of programme machine working for junctions on a busy section of tube line. The first installation at Kennington was made in January, 1958, programme machine working for the junctions at Camden Town was brought into service in June, 1958, and for those at Euston in November, 1958; and this then constitutes a complete system.

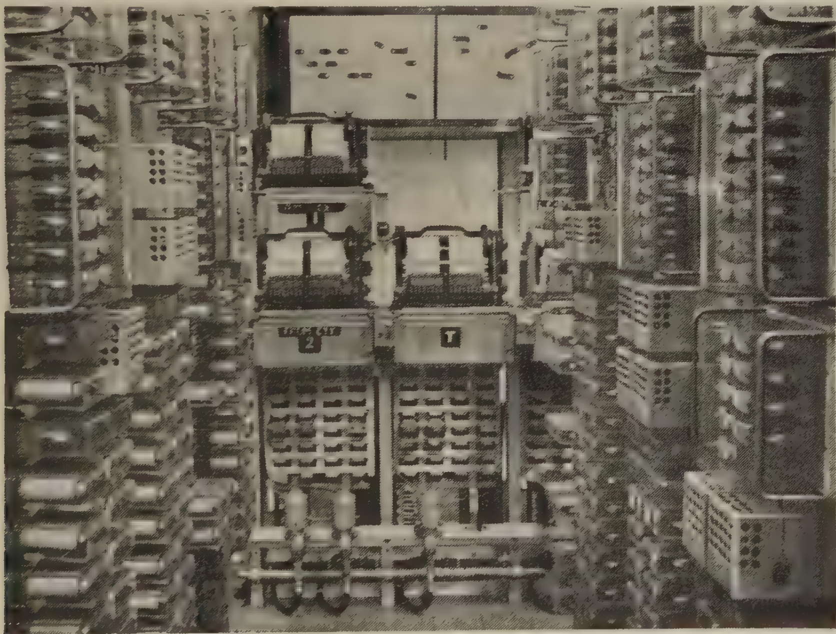


Fig. 14. — Programme machines and associated relays operating the junctions at Camden Town.

Figure 13 shows the programme machines for operating the Kennington layout.

Figure 14 shows some of the programme machines, with their relays, for operating the Camden Town junctions.

The above description covers the

Programme machine control of a terminus.

A further development of programme machine working has already been installed by London Transport at a terminus at one end of a branch line. This

is a terminus having two platform tracks and two sidings. No signalman is employed and programme machine working controls the whole of the terminus operations. The following movements are dealt with :

1) the reversing of trains in either of the two platform tracks and the despatching of the trains at the correct time;

2) in the case of a locomotive-hauled train, the shunting of the locomotive by means of a run-round from one end of the train to the other, and the despatching of the train at the correct time;

3) the routeing of an empty train from the platform into the siding;

4) the routeing of a train from the siding into the platform and, after allowing time for passengers to enter, despatching it at the correct time.

[614 .8]

The dynamic effect of colour in workshops.

Contribution to the psychological prevention of accidents,

by Bundesbahnrat Günter BEHLING, Hamburg.

(*Glasers Annalen*, No. 7, July 1957.)

1. Dynamic effect of colour and psychology.

The value of the dynamic effect of colour is concentrated on the man when working. If we can increase his impression of well-being, his morale will automatically be lifted and at the same time his output; nervous stresses and profitless fatigue are eliminated to a large extent, accidents are avoided and the quality of the product is improved.

At first sight, it may appear extraordinary that such success may be achieved by means of colours. It should, however, be remembered that for years industry has expended millions on time studies and motion studies in order to reduce physical fatigue. Frequently, it has been the minor details which have made the work easier.

Scientific research demonstrates that visual improvements in working conditions react in a surprising way on the general well-being of the individual.

Unlike the edicts of fashion and the up-to-date layout and presentation of the premises, shops, workshops and industrial installations are frequently found to be inside and out a show of dirty and uniform drabness. Even when originally the walls were given a coat of paint as white as snow, soot, steam and dust as well as the impossibility of cleaning them, have evolved in time into a typical dirty grey workshop and working atmosphere. In current language, this is known as the « daily drabness » with the following psychological repercussions: lack of pleasure in the work being done, lack of interest, and as the day's work approaches its end, less attention given to the operation involved in the work. The worker becomes brutalised and acts like a machine.

In view of the efforts deployed at the present time as a result of the most recent knowledge acquired in the organisation of the place of work, these conditions evidently are no longer the general rule. Nonetheless, the monotony of the typical workshop and its exterior appearance even today is increased by the general use of grey or blue grey on machine tools, benches, cranes, partitions, etc., both in the shop and in the yard. This makes even more marked the « greyness of work » which tires the worker, adds to his inattention and as a result increases accidents.

2. The man at work as a factor of insecurity.

During recent years, *industry* and *transport* result every day in more than 55 deaths and over 3 000 injured people in German Federal Territory, and these figures tend to increase. Seventy percent of these figures apply to males. Today *a violent death* is the principal cause of decrease of the labourer under 45 years of age.

The index — the coefficient of frequency of accidents — this year again shows an appreciable increase. As a result of the ever growing use of new machinery, the mechanical forces at work are ever greater. If man is to remain master of the machine, an *increase in his sense of responsibility* is the only counter-balance.

In each accident case considered, the problem at the present time is usually con-

sidered in the following way during the public discussion :

— is the worker capable in his working surroundings to meet during the whole duration of the working day the demands made on him by the machine and the technique ?

Or again :

— in view of the ever growing mechanisation, does the machine threaten to transform the worker into a slave responsible for attending it ?

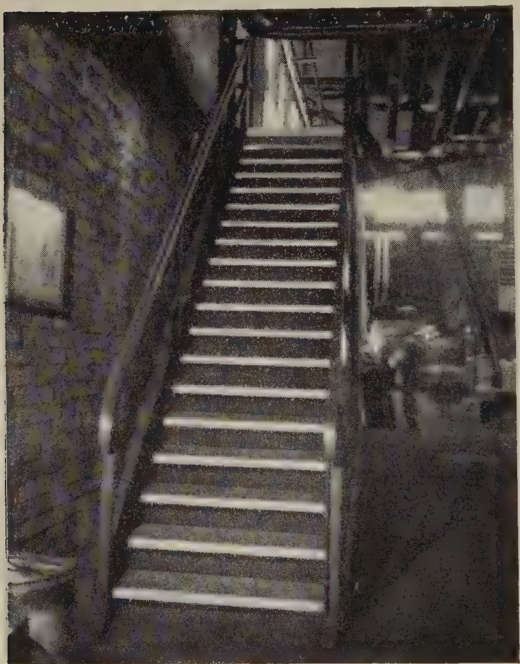


Fig. 1. — Staircase : risk of stumbling (steps and hand-rail).

According to the world coefficient of accident frequency which agrees with the results of investigations made in German industry, including the Deutsche Bundesbahn, at least three quarters of the working accidents are due to human failure — which does not signify fault — and only one quarter to inadequate technical knowledge and fortuitous circumstances, these latter representing the major part of the 25 % in question. The 75 % of accident causes « due to persons » can be divided on the average as follows :

Lack of care	61 %
Failure to observe accident preventation regulations	8 %
Fault of other workers	6 %
	75 %

This percentage figure shows quite clearly that man with his characteristics and qualities should be the focus of the investigations and of all measures to be taken for the work of prevention of accident to be successful.

New centres of gravity have to be set up in the work of accident prevention. The worker has to be contacted *directly* and *visibly*. This is where the psychological prevention of accidents comes into the picture. Its object is to act directly on the worker « face on », and to appeal to his personal sentiments and to his prudence.

3. Psychological prevention of accidents.

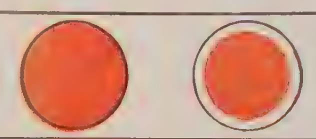
3.1. *Those responsible for the tasks of accident prevention.*

As a whole the psychological prevention of accidents is the responsibility of the workshop managers, their safety engineers, and the staff committees. The constant personal action on the individual or at least on his foreman or chargehand helps to remove the mental stupor so often observed during the work. Here, we are not thinking especially of well organised mass production. It may have good results as regards working accidents. Its monotony no doubt leads to a certain reduction in conscientious attention. Everybody is well aware that universal and constantly alert attention is practically speaking not possible. In many spheres of activity, we are happy to have *automation* or in other words operations done unwittingly, which

TABLE 1. — **Signification and use of safety colours.**

	Red.	**Yellow.**	**Green.**	**Blue.**
Princip. colour.	RAL 3000	RAL 1004	RAL 6001	RAL 5010
Limit shades.	RAL 2002 RAL 3002	RAL 1012 RAL 1007	RAL 6010 RAL 6002	RAL 5007 RAL 5002
Contrast colour.	White.	Black.	White.	White.
Meaning.	Red is particularly suitable due to its psychological properties for application in the average field of labour. Of all colours, it has the highest « coefficient of excitation ». It spells disquiet. A danger spot painted red stands out and appears to be closer to the eye than for example the grey paint on machines, and so warns more vividly of the approach of danger.	Yellow is the first colour to be seen in the visual field. It acts in a particularly insistent and lasting way and is more easily seen than any other colour even in artificial light in the shops. Yellow warms the worker.	Whereas yellow and red are used to indicate danger spots, green is used everywhere to indicate « no danger ». The sight of green is restful to the eye. There is no opposite colour.	Blue radiates calm and is applied to mark general instructions: methods of organisation and advices presupposing a calm and concentrated act.
Application.	Stop! Immediate danger! Danger limit for example stop and not pass signal. Light signals on machines to indicate current is switched on — lighted up arrows in electrotechnique, barriers, limitations and obstacles in the transport field. With the opposed colour: red and white bands on a barrier. Prohibition. For example: panels interdicting all sorts of things: smoking, passing. Emergency stopping devices. For example: emergency levers, devices for cutting off the current of all kinds, emergency shut down valves in mains; alarm signals; cut out switches in electrical installations in case of danger. Fire fighting. For example: installations and notices on fire fighting equipment; special extinguishing arrangements.	Attention! Warning of hidden or potential dangers, for example warning against arrangements or materials which could cause damage, amongst others risk of fire or explosion, tanks of inflammable materials, marking off places exposed to fire or explosion, risk of chemical accidents, marking off places involving a risk of asphyxiation or poison, tanks of dangerous, harmful or acid products, risk of X-rays or radio activity, danger from machines: inside moveable turrets of machine tools and parts therein, sharp edges and moving parts of machines needing special care; equipment for feeding the machines and appliances which when set in motion may injure unwarned persons. Risks of falls or shocks. For example marking off places where there is danger of collision, falls, stumbling and being run over; amongst others: limitation of gauge, girders and mains projecting into pathways; certain first and last steps of staircases, sumps, edges of doors of horizontally closing lift doors, outer edges of cranes, freely suspended pulley blocks, conveyor belts. With opposite colour: tiger type stripes.	Absence of danger: way free. For example: marking the machine is stopped, for example witness lamps of machine tools. Marking the exit doors in meeting rooms and emergency exits in workshops and the indicating posters and panels relating thereto. First Aid. For example showing the places (first aid posts) and material for first aid, location of gas masks, oxygen apparatus, stretchers. Indicating panels to the first aid post.	Directions relating to safety. For example: wearing safety spectacles, breathing apparatus, indicating phonic boxes, first aid posts. Orders. For example: indication of the direction of running, notice to cyclists to alight; parking places and other circulation orders.

TABLE 2. — **Safety signals.**

	The circle or circular ring in the safety colour red has the meaning of « interdiction ».
	The triangle in the safety colour yellow has the meaning of a warning.
	The green cross or the white cross on a green ground is a first aid signal and of absence of danger.
	The rectangle in the safety colours red, yellow or green can be used to underline explanatory notices. The blue rectangle is used by itself.

cause the operator to do instinctively what he is required to do. In my duty as head of the Accident Prevention Service in the sheds and shops of the Hamburg area of the Bundesbahn, I have had to recognise many times that personal action on the worker as an individual cannot be pushed too far. We may be tempted to agree that his attention also grows mossy on this side. This however largely depends upon the quality of the staff of the Safety Engineer who, in the opinion of all professionals and in particular of the Americans who in this field have made great progress and obtained important successes, ought to be the best member of the staff and not just any employee who has become useless for production and is considered to be only just good enough to fulfil the functions of the Chief Safety Engineer. The records I made on site compared with the accident returns have led me to state that this action should be controlled according to the seasons. Experience shows in fact that the accident frequency is higher in the autumn and spring months than during the rest of the year. These accident « high spots » should be considered with some degree of probability as « *crises of adaptation* » seeing that in spring and autumn a modification occurs in the « *vegetative nervous system* ». In the psychological prevention of accidents, it is therefore desirable to pay quite particular attention to these seasons.

3.2. *Accident prevention methods.*

Means whereby the attainment of this objective may be realised are amongst others :

posters (printed notices or pictures);

photographs and films;

effects from colours.

Fig. 2. — Narrowing of gauge : risk of crushing

Up to the present time, little attention has been given to the industrial reaction on the worker of colour. In many establishments, as we have remarked above, the use of colour is restricted to its purpose as a necessary but tiresome covering for the walls, ceiling and metal parts. It is hardly realised that here there is a simple, cheap and unusually universal means for the psychological prevention of accidents, the improvement in cleanliness and order, and consequently for an increase in productivity.

4. **Influence of colour.**

A rational employment of colour :

— is a permanent and visible warning

Fig. 3. — Protective barriers.

and danger signal. It makes it easier to recognise quickly and perfectly all the danger points and all the safety equipment;

— it plays its part in orderliness and prevents accidents due to lack of order (painted lines on workshop floors for truck paths through the shops and stores).

In the following considerations, the vast field of the application of colour will be touched upon only within the limits of the possibilities offered thereby for the prevention of workshop accidents. The problem of colour in the decoration of workshop yards and stores will not be examined.

Before dealing with the subject itself, a question arises at once :

What will be the cost of obtaining the results ?

Apart from the precautionary measures and subsequently the legal and moral obligations incumbent on all undertakings from the commercial angle, the workshops which have adopted safety colours have succeeded in reducing by 20 to 40 % the accident figures within a year. This reduction also ensues a reduction in the costs of accidents which can be divided as between :

— direct charges, i.e. those required to remove the direct consequence of the accident and the cost of the cure;

— indirect charges which comprise : lost working time by the victim;

— loss of working time by his colleagues giving first aid and also by those showing sympathy, curiosity, etc.;

— reduction in production;

— damage to the machinery and installations;

— legal costs of indemnity (pensions) and law costs;

— costs of professional assistance (rehabilitation).

5. The dynamics of colour.

The Road Code having established regulations of general application for colour signals, used for warning, obligatory compliance and interdiction, and also for indi-

Fig. 4. — Protective barriers.

cators, efforts are made to apply this unification in all undertakings to ensure safe working. From this point of view, it seemed desirable to give to the colours and safety signals as a whole the signification they had in road traffic and to adjust them to meet existing national and international conditions.

5.1. *Object and nature of the identification.*

The colours are used to signal dangers and to give warning thereof. Their *utilisation* therefore ought to be limited to *important cases,* because if there are *too many* signals in the visual field, *all their efficacy is lost* and they may be a source of mistakes — see road circulation. The parts, objects, etc., to be pointed out can be covered over wholly or in part with the safety colour. The method of characterisation must bring out sharply that the paint applied ought to add to safety. The association of colours with special safety signals adds to their significance. The visibility of the colours in addition can be markedly increased by the use of a contrasting colour as this attracts attention more strongly.

The safety colours should be prepared in such manner that the shade is sufficiently stable in the operating conditions to be expected and that it remains clearly visible.

The colours and safety signals in no way replace the protective measures that may be required.

5.2. *Safety colours, their signification and application.*

The safety colours are : red, yellow, green and blue. The main shades indicated should be observed as far as possible. To the extent the lighting conditions, the dimensions of the surface, the background and environment make it unavoidable to depart from the shades indicated, this can be done in such a manner as to remain within the range of limiting values indicated (RAL shades). Table 1 gives detailed indications.

5.3. *Safety signals.*

As has been said already, the safety signals should facilitate the identification and the effect of the safety colours. They are geometrical in form and may or may not have borders (Table 2).

Fig. 5. — Warning board before a mobile danger point.

N. B. — Vorsicht ! Spillseil = Attention ! Capstan rope.

Any inscriptions found desirable may be written on the safety signals in the safety colour or the corresponding contrasting colour.

6. Suggestions for the introduction of safety and order signals.

Any attempts relating to the psychology of colours should tend only to awaken and release associations of ideas already present

subconsciously in the worker. The indicated colours correspond to certain human sentimental impressions which should be constantly brought before the eyes of each worker as innate associations of ideas. The staff should all the time feel it is in the « front line ». Each workman, each ganger and each foreman must be well aware of the danger spots there are about the place where they work and of the way attention should be called to them.

bands running down outwards the opening of the passage. In the case of road danger signals [1] alike as on tramway signals, the stripes are arranged to run down towards the opening of the passage.

For the sake of uniformity these prescriptions now in force ought to be followed.

Protective barriers (fig. 3 and 4) which have proved valuable in practice, protect careless workers from the dangers of crossing the lines; the painting increases the

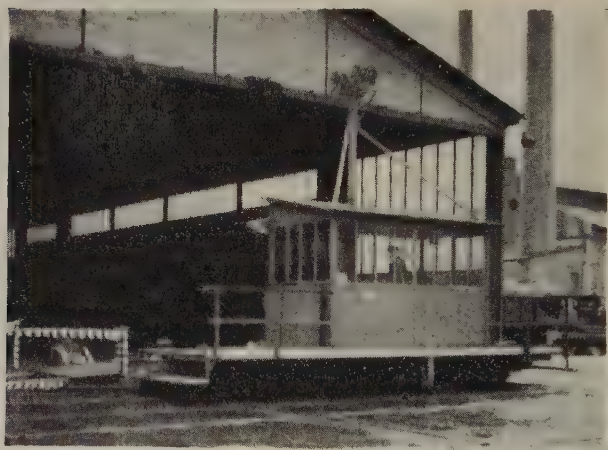


Fig. 6. — Warning marks on a transporter.

force of the warning. The same applies to machines inside a shop. We should point out here bands painted yellow/black that although possessing a lower reflective power than the white/red combination, have given very good results in the open, in the workshop yards as well.

7. Practical examples.

Precaution.

Stationary danger spots.

The basic colour to give warning of the presence of these danger spots is yellow.

As regards stairs (fig. 1) it is often sufficient to call attention to the beginning and end of the stairs (first and last step), but a too large diffusion of the safety colour can reduce its value.

The « yellow and black tiger stripes » are especially striking when there is a narrowing of the passage (fig. 2), thanks to the great luminous intensity of yellow shown up by black.

In the example shown the design has

Moveable danger spots.

Figure 5 shows a warning pole to signal a danger point which is moveable on ground level.

The marks showing the limits of the tranship trucks (fig. 6) are « yellow » and of a « tiger » pattern.

---

(1) « Bundesgesetzblatt », I, 1956, pp. 353-354.

Fig. 7. — « Tiger » stripes overhead.

Moveable danger points « overhead ».

There is some argument about the effect of the design with coloured stripes (fig. 7) because the three black stripes ought to be painted not only on the frame of the gantry but also on the hook the latter being very dangerous to the men's heads, especially as its height is ever changing, whereas the gantry itself moves to and fro in the same plane, outside the zone of danger to the staff.

It is also suggested that for small pulley blocks of crane, yellow paint without black bands is sufficient. The black bands should not be omitted because they favour the perception of depth whereas the yellow paint of the suspended parts peels off quickly being exposed to many impacts.

Figure 8 shows lifting equipment in a wagon repair shop.

The panels « Stop », « First aid », « General notices and warning » are so well known that it seems unnecessary to comment upon them.

Delimitation lines (black-white).

Black and white are the basic colours used to mark off the circulation passages and the places where materials are to be placed in working service. Depending upon local conditions, pure white, pure black, or squares or rectangles in black and white can be used. With the increasing use of fast electric vehicles inside the shops, we meet in the shops with a heavy movement of materials problems similar to those on the roads. The workers must be protected by clearly marking off the gangways and

Fig. 8. — Stripes on a device for lifting goods wagons.

the truck drivers must have their attention drawn to danger spots. Warnings of caution can be strengthened by putting up a directing arrow in white on the centre line of the pathway. Apart from the white direction lines, in certain undertakings with heavy interior traffic, steps have already been taken to see that the material used in making the pathway has a lighter or darker colour than that of the areas alongside it (for example different colours of concrete). Black and white are used not only to mark off the pathways, but also in the area where stock is to be carried. Good order means safety where accidents are concerned.

8. Conclusion.

By adding to the painting of the tool equipment under the conditions we have just shown another essential element in preventing accidents, namely attention which appears to me to have considerable importance, we can obtain at low cost a marked reduction in accident frequency.

We know we must do everything possible in the field of accident prevention to select methods that will be effective. The dynamics of colour is one of the ways leading to this end. It helps to reduce the number and severity of accidents at work and consequently deserves to be integrated more and more into the study of accident prevention.

Summary.

Statistics show that human failings — not to be confounded with faults — are responsible for some 75 % of the accidents at work. Psychological preventive measures thus assume particular importance. In these is included a suitable utilisation of the dynamics of colours : its importance is stressed in the present article in which is also described the application of the four safety colours : red, yellow, green and blue, with comments by illustrated examples.

[625 .143 .1]

Some experimental methods of investigating Rail Section Design,

by A. S. Babb, A.M.I.Mech.E., A.M.I.Loco.E. (*),

and

W. C. Heselwood, B.Sc., A.Met., F.I.M. (*),

(From the *Railway Steel Topics*, Volume 4, Spring 1958, No. 3.)

The requirements for an ideal rail section are stated, and three procedures of stress determination which have been used at Swinden Laboratories for rail section investigation are described. These are (i) the 2-dimensional photo-elastic technique, (ii) direct measurement by electrical resistance strain gauges applied to short rail specimens loaded in an orthodox Buckton compression tension testing machine and (iii) the loading of a 12 ft. length of track in a specially constructed test frame again using electrical gauges for the strain measurement.

Introduction.

A previous article in *Railway Steel Topics,* traced the development of rail sections, from the very early forms up to today's flat bottomed sections. Amongst the requirements of a good rail section are :

a) sufficient beam strength to carry the maximum vertical and lateral loads without excessive bending stress or undue deflection. What constitutes sufficient strength will vary somewhat with the nature of the terrain over which the track is to be laid, and with the desired standard of track maintenance. In the case of railways carrying very intensive traffic, it may be economical to lay rails having a higher beam strength than is required from stress considerations, in order to reduce the subsequent work required to maintain good alignment;

b) sufficient width and depth of head to provide a reasonable length of service before the rail has to be scrapped or moved to a less arduous duty due to reduction of sectional area and consequent loss of strength;

c) adequate web strength to support the head and to transmit the vertical and lateral loads to the section as a whole without setting up high secondary stresses;

d) in the case of flat bottomed rails, adequate flange width to spread the load over the rail support, and to resist overturning when subjected to lateral forces. This is particularly important if the rails are to be laid directly onto wooden sleepers, without the use of soleplates;

e) adequate fishing surfaces so as to reduce joint wear. This feature might become of less importance should the use of long welded lengths become widespread, but as far as the writers are aware no section has yet been designed with the object of long welded lengths specifically in mind;

f) the section should be proportioned so as to facilitate the rolling process in manufacture and as far as possible to promote even cooling throughout the section after rolling. This requirement calls for good liaison between the railway engineer and the rail maker when new sections are being designed;

(*) Both authors are at the Research and Development Department of the United Steel Companies Limited. Mr. A. S. Babb is Development Engineer (Trackwork and Structures) and Mr. W. C. Heselwood is Chief Physicist.

g) cost considerations obviously dictate that the weight and hence cross-sectional area should be a minimum consistent with the other requirements.

These requirements are in some respects conflicting and every section is therefore a compromise according to the duty for which it is intended.

Sometimes what would at first thought appear to the layman to be quite minor features of the design of a section prove after years in service to be of the greatest importance. An example of this is the proportioning of the radii by which the web is blended into the head and base of the rail. The use of radii which are too sharp has resulted in more than one instance in serious trouble due to fatigue failures starting at the point of sudden change of section.

Undoubtedly the surest method of testing the suitability of a section for a given duty is a service test of several miles of track over a period of many years. This, however, is both expensive and too slow. This article is concerned with laboratory methods which have been used and developed for determining the stresses in rails when subjected to given loading, so enabling more rapid comparisons to be made between different sections.

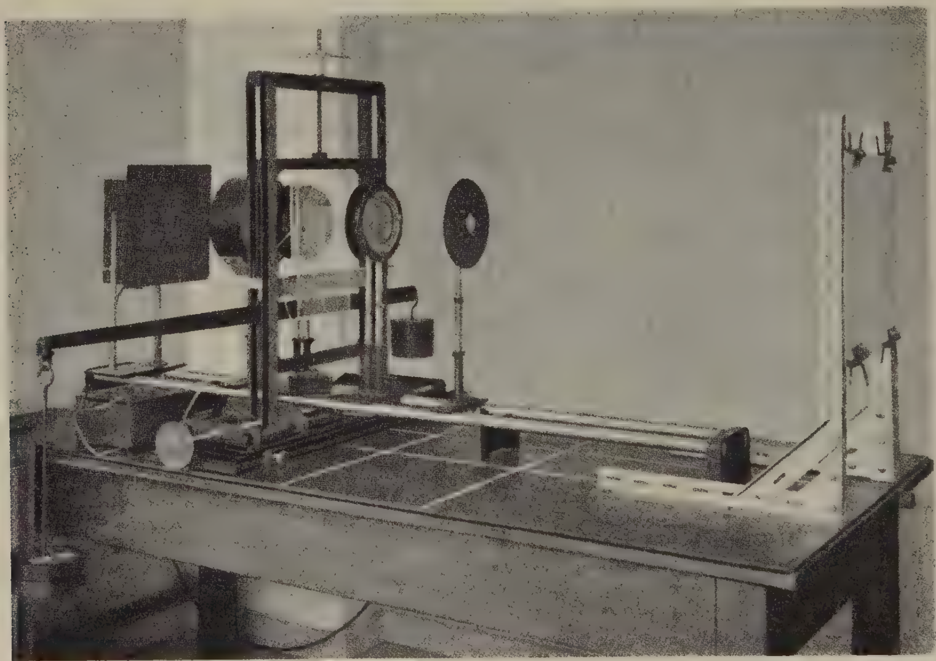


Fig. 1. — Photo-elastic testing apparatus.

The first problems of section design with which the writers were concerned related to the shape of the under head fillets in rails ranging from 60 to 109 lb./yd. The two-dimensional photo-elastic technique seemed to offer the best means of first approach and gave valuable comparative information. The limitations of a two-dimensional method were, however, appreciated, particularly that in a rail in the track :

(i) the rail length in the third dimension resists the torsion of the head and the bending of the web suffered by the two-dimensional model;

(ii) the load is not supported entirely by the section immediately underneath the area of rail/wheel contact but is « spread » along the rail.

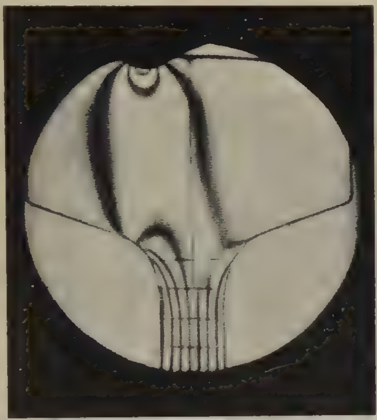


Fig. 2. — Stress pattern of 95 N.B.S. rail showing effects of eccentricity.

The absence in the two-dimensional model of the longitudinal stresses set up by the bending of the rail as a beam may, however, be regarded as an advantage when investigating stress concentration effects in the fillet areas.

A separate series of tests was planned in which actual rail lengths were loaded in an orthodox compression/tension testing machine. The magnitude and direction of the surface stresses at selected positions were measured using electrical resistance strain gauges. The previous photo-elastic results were used as a guide to the most appropriate positions at which to affix the strain gauges. The use of electrical resistance strain gauges in this way proved so useful that a more elaborate test frame was constructed in which a length of rail could be loaded vertically and laterally, and simultaneously subjected to an appropriate bending moment. This allows close simulation of any normal track conditions.

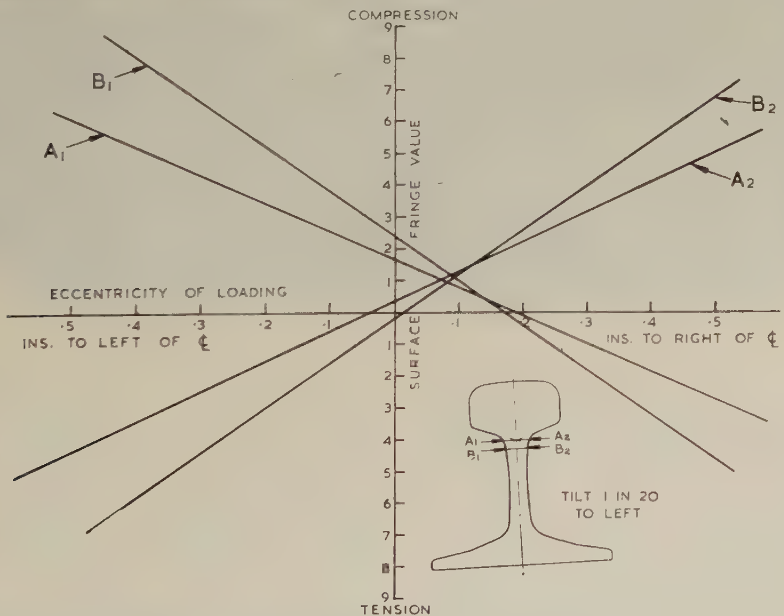


Fig. 3. — Variation of surface fringe value at two positions with eccentricity of loading. 95 N.B.S. rail inclined at 1 in 20. 50 lb. load.

Photo-elastic method.

The photo-elastic technique is comparatively simple and rapid. A full size model of the rail section under examination is carefully cut out of an optically sensitive material (in this case Cr. 39 resin usually about 1/4 in. thick) and set up in a loading frame to simulate track conditions (e.g. it is tilted at an angle of I in 20). Figure 1 shows the general arrangement. Monochromatic light from a mercury vapour lamp and green filter passes successively through :

a polarising optical system;

the model;

an analysing optical system,

and is projected on to a screen where interference patterns as shown in fig. 2 are produced. This figure may be likened to a contour map, the contours in this case representing positions of equal principal stress difference (i.e. shear stress). Whilst the model is being loaded the contours may be seen to spread from the regions of highest stress like ripples on a pond spreading from a stone thrown into it. Shear stress at any point is proportional to the number of fringes (or contours) counted from an unstressed area or counted as they appear on the screen during loading. The fringe values could be converted to absolute values of stress in a rail making allowance for the differences in Young's Modulus of the model material and steel, but, as the model does not take account of the bending stresses acting perpendicularly to its plane, the writers prefer to confine the measurments to the numbers of fringes and make relative comparisons between different sections and different loadings.

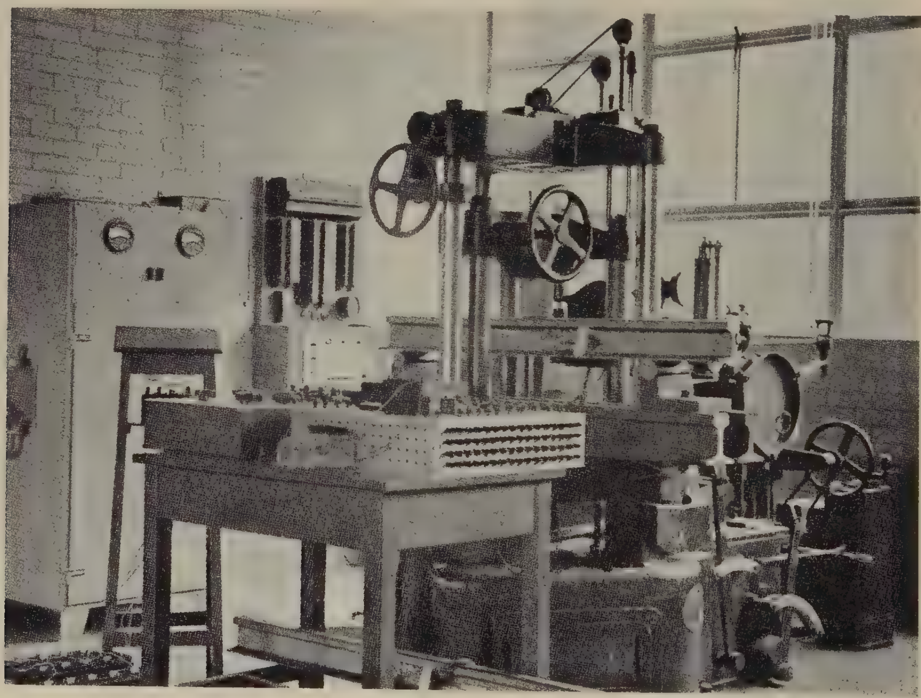


Fig. 4. — Testing 80 R.B.S. rail in a Buckton machine.

The results can be plotted as in figure 3 to show how surface fringe values at particular heights on the rail vary with eccentricity of loading. Such diagrams plotted for several heights and for each section under consideration enable comparisons to be made.

Electrical resistance strain gauge method.

(i) *Loading in a Buckton testing machine.*

In order to provide a check on the results of the photo-elastic model and to establish the actual magnitude of the stresses in rail fillets and webs a test rig was built so that samples of certain existing rail sections could be loaded in a Buckton Universal Testing machine and strains measured by means of electrical resistance strain gauges.

A general photograph of the Buckton machine with the test rig in position is shown in figure 4 whilst figure 5 shows a close-up of a rail under test. The rail could be either simply supported as shown in figure 4, or supported on three soleplates, the deflection under the point of loading being controlled by means of shims under the outer soleplates, so that the bending moment in the rail was of the correct magnitude to simulate a given service condition. The load was applied to wires welded on to the rail head at given eccentricities through a Tee-section radiused in one plane to represent a wheel and grooved in the other plane to fit the wires. The Tee-section was cut from a piece of high tensile (30 tons/sq. in. yield) rolled steel joist, so that it should be as flexible as possible. This arrangement does not reproduce the correct contact stresses in the head, but was adopted so as to give accurate location and reproducibility of eccentricity which is of the utmost importance. Four horizontal rows of three strain gauges each, as can be seen in figure 5, were cemented to each side of

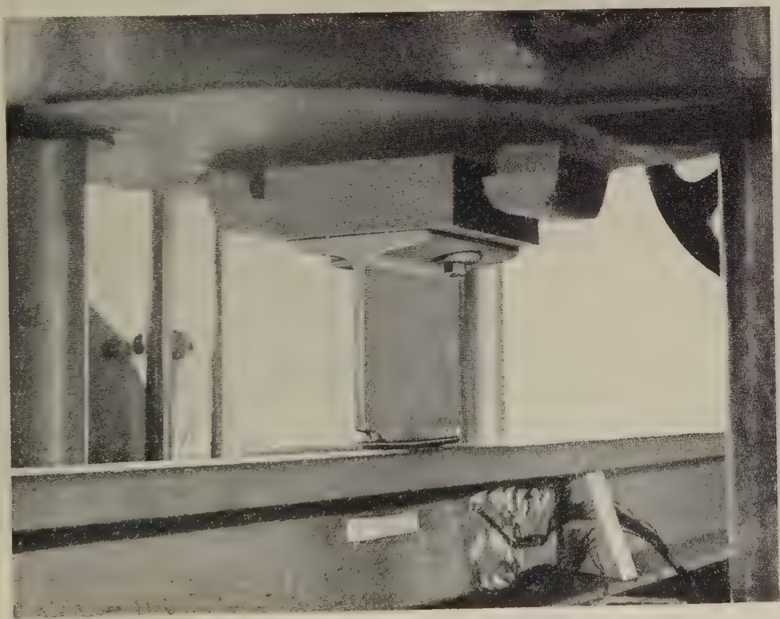


Fig. 5. — 80 R.B.S. rail showing strain gauge.

the web. The gauges in each horizontal row were spaced 1 in. apart and had their axes inclined at 120° to each other. Loads were applied over each gauge in turn, and at other positions in increments of 1 in. along the rail length. The readings of the three gauges in a row, when each gauge was at a given distance from the point of loading, were then used to calculate the magnitudes and directions of the principal stresses (and hence shear stresses) at twenty-eight positions on each side of the web. Thus diagrams of the principal stress trajectories on each side of the web were drawn. A typical example is figure 6. Many conclusions were deduced from these experiments, but are difficult to reduce to general statements for an article such as this. However, the following may be stated :

1) in all sections tested the maximum vertical compressive stresses occur in or near to the upper fillet on the loaded side of the rail;

2) the maximum compressive and shear stresses do not necessarily occur directly under the load, but at a distance of up to 3 in. to either side of the line of loading;

3) maximum upper fillet stresses are higher by 25 to 50 % when the wheel load is directly over a sleeper than when it is at mid-span between sleepers;

4) stresses in the lower fillets are negligible when the load is between sleepers, but are 50 to 75 % of the upper fillet stresses when the load is directly over a sleeper;

5) the upper fillet stresses are more damaging to the material than the lower fillet stresses. This is because the shear stress on a given plane at a given point reverses through a greater range in the upper fillet than it does in the lower fillet, as the wheel passes along the head.

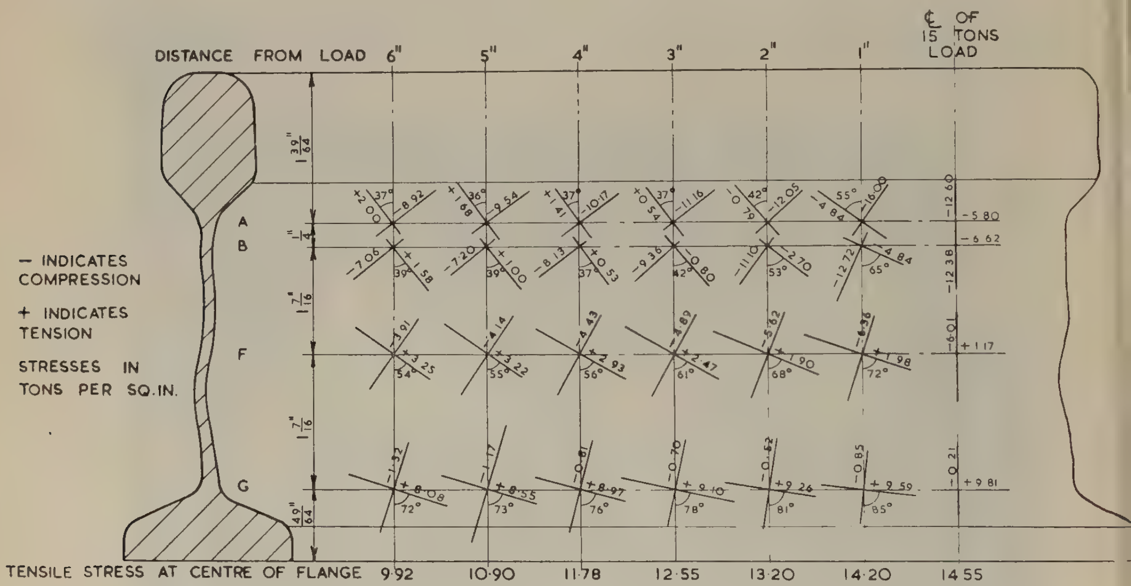


Fig. 6. — Principal stress trajectories on same side of web as load, 80 R.B.S. rail, eccentrically loaded and simply supported.

(ii) *Loading in a special test frame.*

In the tests so far described no attempt was made to apply lateral loads to the rail,

nor was the loading supposed to simulate any particular locomotive on any particular track. The latest step has been to construct a more elaborate test frame which enables the rail to be loaded vertically and laterally, and simultaneously to be subjected to the appropriate bending moment. This apparatus is shown in figure 7. Two twelve-foot lengths of rail are mounted on five steel sleepers supported in the test frame. Vertical loads are applied over the centre sleeper by means of hydraulic jacks. A lateral load is also applied to the rail head over the centre sleeper by jacking the two rails outwards at this point. This is not what happens in a track, but reproduces the correct conditions in the one rail under test and avoids the necessity of constructing a test frame of great lateral rigidity. Also the torsional resistance of the test rail to the eccentric vertical and lateral loads is very near to that of a long rail in the track. Bending is applied to the test rail by hydraulic jacks which thrust upwards on to blocks clipped underneath the rail flange, or underneath the intermediate sleepers. Their position is adjustable so as to be able to reproduce any likely combination of bending moment and load distribution simulating a given locomotive on a given track. For example, as the modulus of the track foundation increases, the proportion of a given total vertical load supported by the centre sleeper increases and the bending moment in the rail decreases.

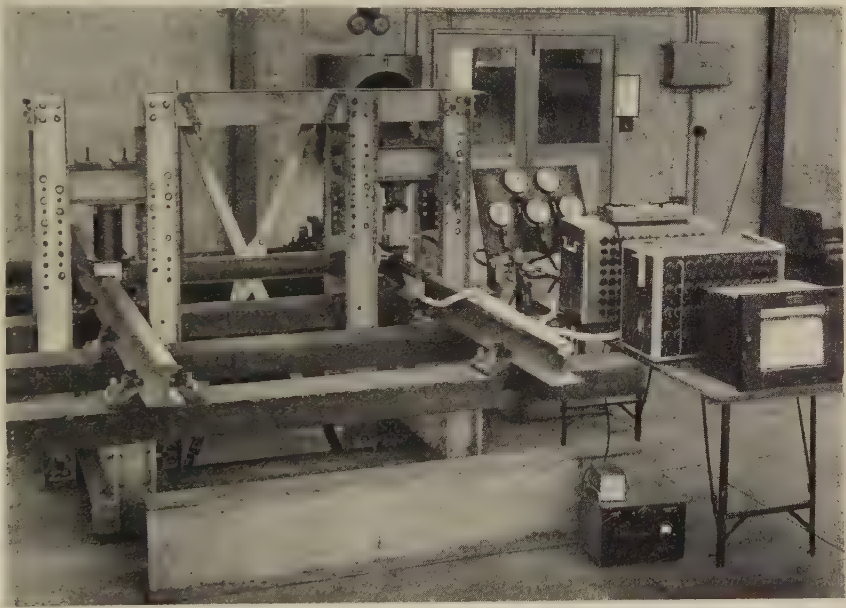


Fig. 7. — Rail test frame and hydraulic loading apparatus.

Both vertical and lateral loads are applied to the test rail through 1/2 in. dia. high tensile rods welded on to the rail head, and sawn into 1 in. lengths after welding. The weld holding each 1 in. length is arranged to be directly over the appropriate row of gauges. Initially these loads were applied by means of a block cut from a machined tyre, the idea being to apply the load in a manner as near as

possible to service conditions. This method was abandoned, however, as it was not found practicable to locate accurately and reproducibly the lines of action of the forces. The lateral and bending jacks are ball jointed at each end.

As previously, strains in the rail are measured by means of electrical resistance strain gauges. The measuring apparatus has, however, been improved, the strains being recorded on a chart recorder, through a 48-channel automatic switching bridge unit specially constructed for the purpose.

The number of gauges required in a given experiment is usually greater than can be fixed in one vertical row, so that it is necessary to load in turn over two or more rows af gauges. The main use to which the test frame has been put so far has been the measurement of web and fillet stresses, although some recordings of bending strains have been made.

Direct bending stresses can be calculated fairly reliably by orthodox theories so long as the load is applied vertically and over the centre line of the web. Under the worst conditions in the track the load is applied eccentrically to one corner of the head, and lateral load is applied simultaneously by the wheel flange. Measurement of the actual strains on the surface of a specimen rail, loaded so as to simulate the particular service conditions, is the only reliable method of ascertaining the maximum strain occurring at any part of the section in this case.

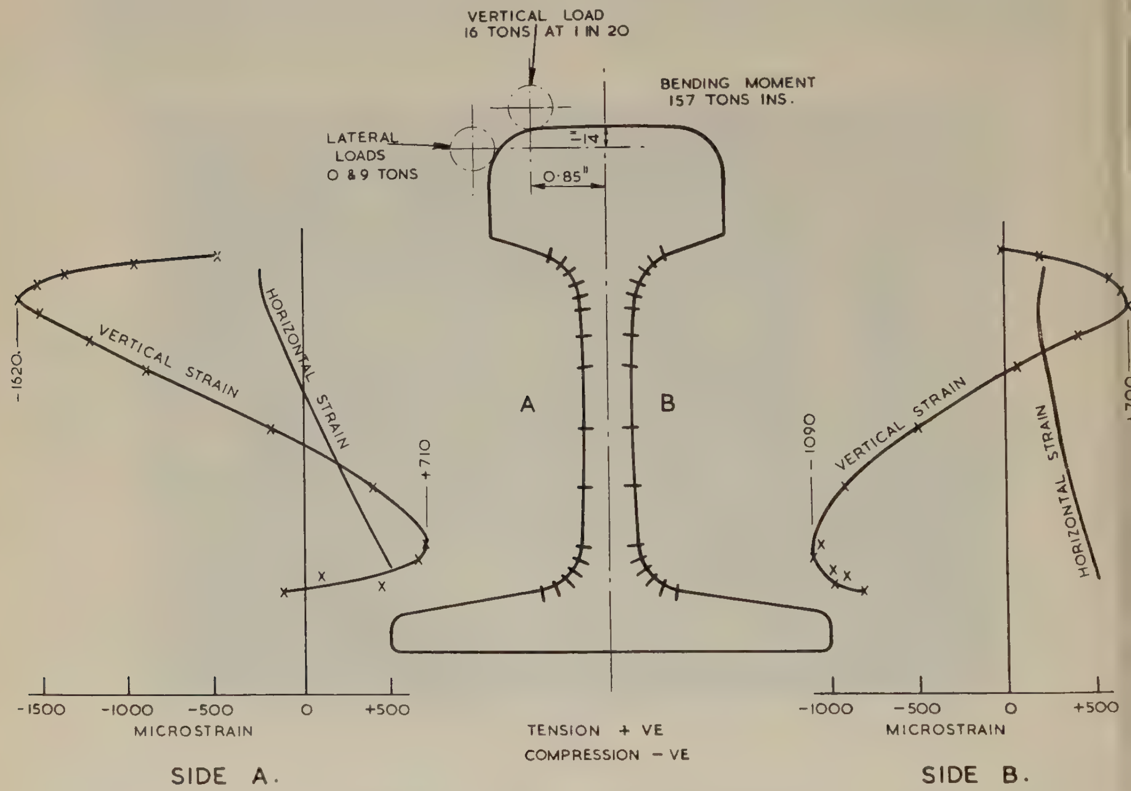


Fig. 8. — Surface strains in a 91 lb. rail, under 1-Co + Co-1 loco loading with 9 tons lateral load.

Figure 8 shows a typical graph of surface strain in a 91 lb. rail under loading representing a 1-Co + Co-1 locomotive having an axleload of 21 1/2 tons and running at 30 m.p.h. with a lateral force on one axle of 9 tons. The bending moment corresponds with a track modulus of 1 000 lb. per in. of rail length to give one inch deflection.

A disadvantage of any technique employing actual lengths of rail is that rolled lengths of proposed, or modified, sections are not available. Specimens have been produced, however, by machining from existing sections which were cut off a mill length before it reached the finishing passes, so as to leave just sufficient machining allowance. So long as the specimen is loaded within its elastic range its behaviour in the test rig should not be affected by the omission of the last finishing passes.

This article has only treated the work concerned (which is still continuing) in a very general manner. Testing experience so far has included the following sections.

Photo-elastic test:

60 R, 80 R, 80 N (1955), 90 ARA, 95 N, 96 SAR, 98 BR, 109 BR.

Tests on specimen rails:

60 R, 80 R, 91 NZ, 91 Special, 95 N

[625 .285]

The panoramic railcar about to be put into service on the S.N.C.F.

(*La Vie du Rail*, 8 June 1958.)

The S.N.C.F. ordered in November 1956 from the Renault Company ten panoramic railcars intended for use on lines of value from the touristic point of view.

These railcars with MGO Diesel engines of 800 HP with electric transmission will form the S.N.C.F. 4200 class. They will operate in express services during the summer on the following lines: Lyons-Toulouse via Mende and Rodez; Lyons-Nimes; Geneva-Nice via Grenoble, Veynes; and Lyons-Marseilles via Grenoble.

Throughout the year, they will operate between Clermont-Ferrand and Nimes via Langeac.

The first panoramic railcar will leave the Works during the summer of 1958. The second will be held back some months before being put into service, so that should any adjustments be found necessary, they will be done during this period.

The class X 4200 railcars have at the middle of the body a raised panoramic compartment with 44 seats reserved for first class passengers. Below this, are the engine room and the luggage section. At each end of the railcar, a second class compartment seating 22 gives these passengers the maximum visual field, little affected by the driving compartment also arranged at the end thanks to a new layout of the structure.

The need to get the panoramic dome inside the S.N.C.F. loading gauge naturally complicated the work of the Designing Division of the Heat Engine Traction Department in which this most original vehicle was designed. It has the following leading dimensions:

Length over buffers: 27.730 m;

Weight empty in running order: approx. 58 t;

Maximum speed: 130 km/h;

One motor bogie, one carrying bogie;

Minimum radius of curve: 150 m.

From the technical point of view, the essential feature of this class of railcars is the use of electric transmission.

Motor bogie.

This bogie was designed by the D.E.A. on the one used on the most recent « All Services » railcars, but in this particular instance, the axle bridge of the « All Services » mechanical transmisison has been replaced by the electric traction motor, and the body side bearings on the bogie have been brought as close to the body sole bars as possible to oppose any tendency to roll.

Carrying bogie.

This is like the motor bogie except that it has no electric traction motor. It is fitted with the driving gear for the Flaman speed recorder.

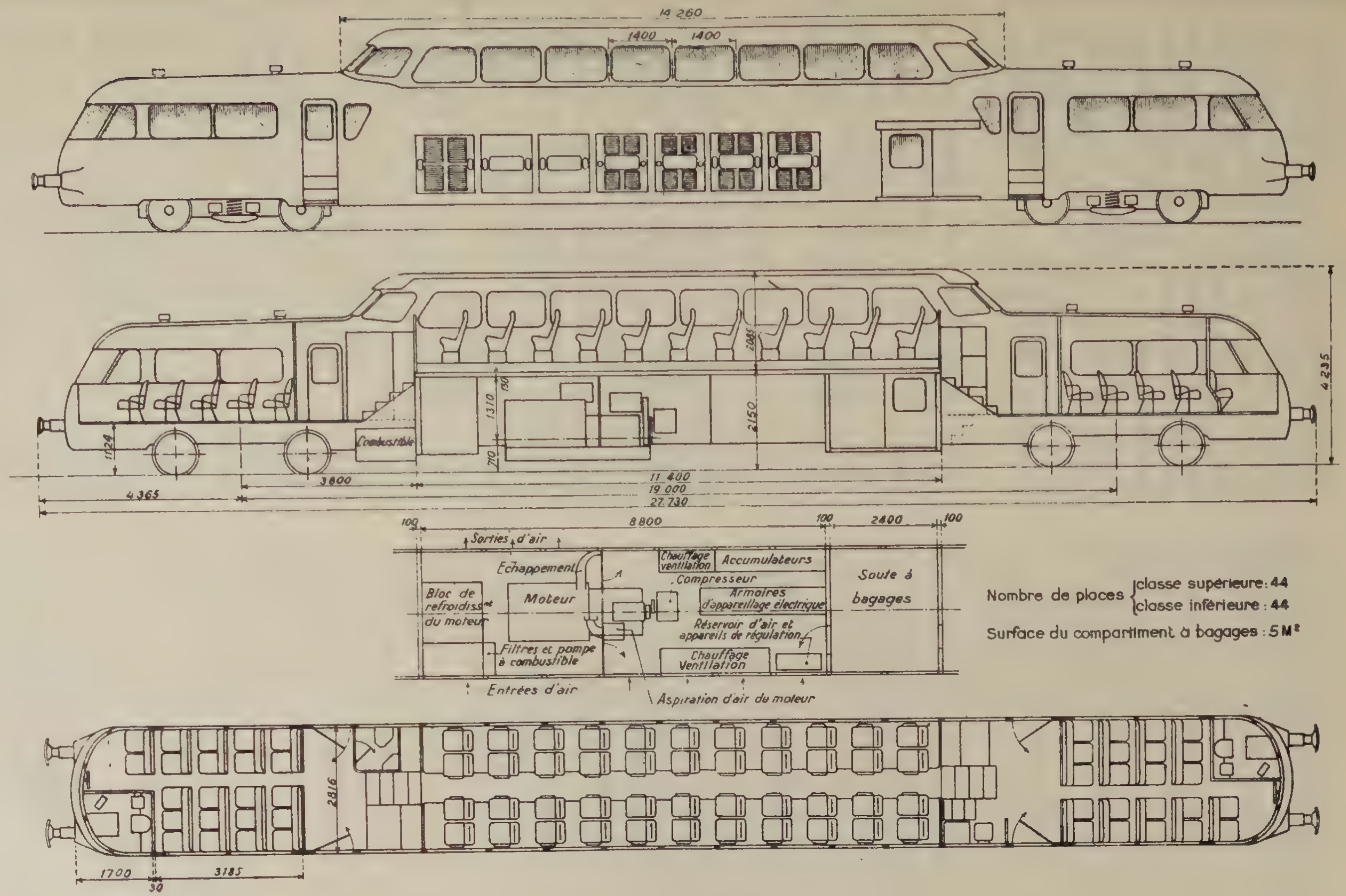
Body framework.

Two side trellis girders have been designed to carry all the load. They are cross braced by:

— the lower members carrying the engine equipment;

— the floor of the raised compartment;

— the built up partitions known as « firebreaks ».



Translation of French wording :

Nombre de places... 5 M² = No. of seats : first class, 44; second class, 44; area of luggage compartment, 5 m². — Bloc... moteur = engine cooling gear. — Sorties d'air = air outlets. — Entrées d'air = air inlets. — Echappement = exhaust. — Moteur = engine. — Chauffage = heating. — Compresseur = compressor. — Filtres... combustible = fuel filters and pump. — Armoires... électriques = electrical equipment cupboards. — Réservoir... régulation = air tank and regulating equipment.

In line with the engine room and that of the auxiliaries, removable panels are fitted to give access to or allow of the removal and replacement of the compressor, fan, etc.

The frame had to be capable of supporting a longitudinal force of 100 t applied to and divided between the two buffers at each end. The first frame was submitted to tests under static loads at the S.N.C.F. Testing Plant at Vitry.

The outer casing in aluminium sheet is not taken into account in the calculations.

Motor equipment.

The *electric generating set* consists of: a type 12 V 175 SH MGO motor with 100 HP Napier turbo-blower, it develops 800 HP at 1 500 r.p.m.

A CEM type G main generator rigidly fastened to the motor casing through a cast steel flange plate.

The motor-generator unit is carried on a cradle suspended at four points to the cross members of the body framing. The main generator drives the compressor and the auxiliary generator by belts.

Engine cooling. — A fan blows air over the radiator elements. The D.E.A. is trying two schemes:

Five railcars will have Voith gear and five Chausson.

The fan shaft is driven by means of a:

Hydraulic coupling with automatic variable filling in the Voith design;

Alsthom magnetic clutch controlled by a three contact thermostat in the Chausson layout.

In both arrangements, the regulation of the temperature of the engine cooling water is assured within the limits laid down by the engine builder.

A loop off the cooling circuit provides the railcar heating.

Exhaust. — On the first railcar of the class the main exhaust is arranged at the side on a level with the sole bar on the side opposite to that on which the openings through which oil is drawn are fitted. The idling exhaust is on the same side as the air inlets. A valve operated by the driver enables him to change from one exhaust to the other. According to the results found during the tests, the idling equipment will or will not be retained.

Fuel supply. — Three fuel tanks holding a total of 1 500 l in plastic material are fitted below the frame. The fuel is heated by a loop off the hot water line serving the carriage heating.

Method of lifting heavy components. — In the engine room, brackets for lifting appliances have been provided to make it easier to handle the generating set, the cooling gear, the electric apparatus cupboard, the compressor and the auxiliary generator.

Air conditioning.

Heating. — The panoramic compartment is heated by two electro-fans drawing air through filters arranged on the face opposite the accumulators. The air heated by the radiators fed by the engine cooling water is driven into conduits arranged on each face of the panoramic compartment. « Sopal » aerotherms fed on loops off the engine cooling water system heat the end compartments.

Ventilation in summer. — The two electro-fans of the winter heating are used for summer ventilation (the radiators naturally being cut out). The distribution of the air is effected as follows:

— through orifices provided in the faces at floor level and at waist level at the windows with a diffuser under passenger control;

— through a conduit placed in the top of the dome.

Control and regulation. — The guard operates the air conditioning from his compartment by means of a 4 position switch:

0 = closed; 1 = automatic heating;

2 = manual control with slight ventilation; 4 = full ventilation.

Air conditioning. — An air conditioning set will be fitted experimentally on one railcar of the class. The air is blown through orifices in plastic conduits fitted in the roof of the panoramic dome. In addition, two outlets arranged in the ends will discharge towards the centre part at head height.

This group of 10 HP can lower the temperature of 2 450 m^3 of air per hour from 29° to 17.5° C.

The Westinghouse Company designed and supplied the heating and air conditioning sets.

New constructional arrangements.

Panoramic dome. — The top of the dome (above the bottom of the windows) is made of mouldered layered polyester. This section of more than 14 m in length is built up of four sections bolted to the body framing. The sealing between the parts is provided by rubber joints.

This is the first time a plastic construction of such size has been undertaken, and if successful will open entirely new perspectives on future rolling stock construction.

It is interesting to note that building in plastics enables coloured parts to be provided as the resins used can be dyed and so all painting work rendered superfluous.

Heating glazing. — Window lights known as « Therglass » supplied by the Boussois Glass Company are fitted throughout the panoramic part of the dome and in the windows facing the driver. They consist of two sheets of glass separated by a transparent plastic sheet (Butiral) in which is inserted a heating element formed by extremely fine wires practically invisible. The use of this glazing may be expected to prevent the formation of frost outside and mist inside, and so maintain the panoramic quality whatever the atmospheric conditions. Such glazing is now used on fighter aircraft.

Driving compartment partition. — In order to give the passengers in the lower compartments the most unrestricted view possible, the driving compartment is glazed all round. The glazed part begins at the window sill level. No pillar impeding visibility is used in building this partition.

The X 4200 panoramic railcar departs to a large measure from well trodden paths. There can be no doubt but that it will meet from the users of the S.N.C.F. touristic lines a well merited success.

[625 .236 (73)]

Mechanization speeds car cleaning,

by Homer G. ALPHA.

(*Modern Railroads*, April 1958).

The reader may wonder why we should emphasize clean cars during April, which is Perfect Shipping month. October was considered Clean Car month, until it was decided to make clean cars a year-round campaign. Hence, since there cannot be « Perfect Shipping » without clean cars — and because there have been a number of significant developments which aid the clean car campaign — this feature has been prepared as an important adjunct of this year's perfect shipping campaign.

PART I.

The problem of car cleaning has always been a major one in the railroad industry. It is becoming even more complex with the increases in the cost of labor, the cyclical shortages of freight cars and the present decline in freight car loading. Customer demands for cars that are clean and in good repair are increasing, primarily because they can get that service in highway trailers, which are handled individually while freight cars are generally handled in groups. Too, service is always an important aspect of the time involved in a car cleaning program.

One of the primary difficulties is the inability of the industry to arrive at a suitable definition for a clean car. Lacking that, a very suitable one made by one of the leaders in the clean car movement is worth noting. E. E. Foulks, Asst. Vice President-Operations, Rock Island Railroad, says, « A clean car is one that when received from the consignee's dock has been cleared of all bracing, blocking, strapping and debris and is ready for *immediate reloading of the same or similar commodity* ».

The magnitude of the car cleaning problem is evident by these pertinent statistics :

— A car sent over the cleaning tracks is out of service for an average minimum of three days;

— The total car cleaning bill of the railroads is more than $ 110 million each year;

— About 17 million car-days are lost each year in cleaning cars and moving them to and from cleaning tracks;

Latest in car cleaning is Santa Fe's new facility. Here 100 cars are lined up, 50 to a side, along a 2 256-ft. stretch of asphalt with drains and special car cleaning equipment.

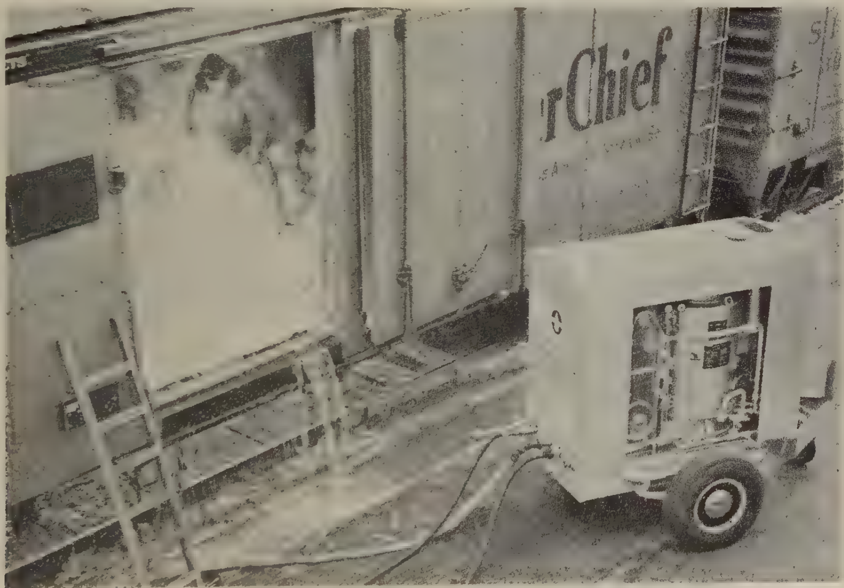
— At an average of \$ 8 000 per unit, about \$ 373 million in capital investment is represented.

Yet the fact remains that one *out of every eight* cars released for service contains debris.

Where is the impact of this unproductive car cleaning operation felt ? Even though most of the responsibility rests with the consignee, the railroads shoulder much of the burden or attempt to do so. The reason is obvious. The railroads are reluctant to exercise their prerogative of refusing cluttered cars and thus continue to collect demurrage. To do so would, in many cases, result in poor industrial relations. Too, most railroads strive to keep a maximum number of cars in the highest possible classification, which has the effect of increasing their freight car fleet. To illustrate, an « A » classification car is available for any loading in an emergency, while a « 5 » or rough classification car is strictly limited in assignment to loading.

Dirty cars. — Problem to shippers.

Shippers are also adversely affected by the problem. When cars are assigned to them for loading and are found to be dirty and/or cluttered, it delays their schedule and adds extra expense to their operation or that of the railroads in replacing the car.



Hot water is used to melt top ice in ice removal job on Santa Fe refrigerator car.
Portable generator is brought to car.

In a survey conducted by *Modern Railroads* (November 1957, p. 118) the question was asked, « Are the cars you receive clean and in good repair ? ». Traffic managers from 16 major shippers answered with a flat « no ». Only 11 gave a « yes », two said « very few », 31 said « mostly », while 25 said « some ».

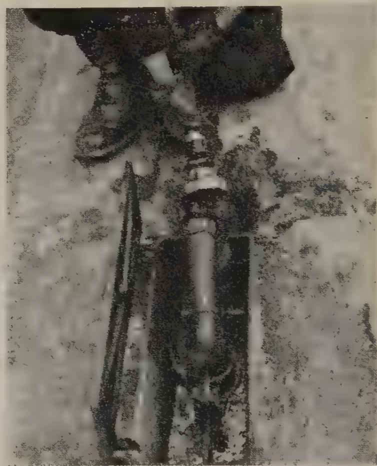
There are a number of reasons for the dirty car. The consignee did not clean the car before releasing it, and the railroad

inspector did not properly inspect and card it. The cars were properly inspected and carded, but the switching crews did not spot the car at the assigned shipper's dock. This is an important point because only a systematic program of education and proper supervision can overcome it. The problem is such that some shippers have found it necessary to employ full-time car inspectors.

Hot water line runs along side of Soo Line's car cleaning track. Take-off uses standard hose.

The obvious question is, « What is being done about the problem of car cleaning ? ». One thing is the National Car Cleaning Committee. This committee was organized out of pure necessity. It was organized as a solution to inter-road competition through a cooperative approach to shippers. Previous to its existence, if ABC Railroad approached a shipper and requested assistance in a car cleaning program, that shipper could inform ABC Railroad that XYZ Railroad did not insist on it and henceforth XYZ Railroad would get the business. Under a cooperative program, all railroads in a given location make a joint request of the shippers.

The committee was organized with three members from both the rails and the shippers. It now consists of seven members from each. It has come a long way and has shown considerable results. Suggestions from both railmen and shippers are welcomed by the committee. Only full co-operation from both will assure positive results.



Water take-offs are provided at convenient locations for portable cleaning machine.

The paramount objective of the railroads in any program is to increase the productivity of their equipment. Since the freight cars are in the hands of the railroads less than 50 % of the time, it should be essential that every effort be made to increase the portion of that time in actual revenue service. Car cleaning is one operation that can help to produce that time.

PART II.

CAR CLEANING TECHNIQUES.

Mechanization of car cleaning facilities is indicative of the determination of the railroads to furnish what the shippers want. With the cost of labor constantly increasing and the shortage of freight cars in the higher classifications, something had to be done to reduce the expense of car cleaning and at the same time increase the fleet of

higher class cars. It is now possible not only to clean a car quickly and thoroughly, but at the same time to upgrade it to a higher classification. The time element has been reduced in the same manner. However, manpower is and will continue to be required to remove strapping, bracing, blocking, nails and heavy debris. Dirt, grease, oil and carry-over bulk loading require the use of cleaners or steam and/or pressurized hot water. There is a growing recognition by railroads of advantages of hot liquid and/or steam cleaning. With that recognition, mechanization is replacing hand cleaning.

A number of railroads are already attacking this problem vigorously. This has resulted in several new techniques for cleaning cars on an efficient production line basis. One of those techniques utilizes equipment that cleans and upgrades with steam, hot water and detergent. The equipment is called The Upgrader, produced by Vapor Heating Corp., Chicago. Its economy and efficiency results from its ability to clean, upgrade and flush from the car all disloged dirt.

Hot-hydraulic cleaning is effective.

The Upgrader was developed to clean cars to their highest classification at the lowest possible cost. One man, using the machine, can far out-produce many men using old-fashioned methods. That is important, since the cost of labor is as high as 90 % of the cost of cleaning a car. The machine produces the four-way action of hot-hydraulic cleaning. High temperature water softens and dissolves the dirt. The high velocity impact of water scrubs and loosens the dirt, and the flood of water flushes and carries the dirt away. In addition, a solvent or detergent, automatically blended, takes care of stubborn dirt and grease.

The machine generates its own high-pressure steam and combines it with cold water in a « Sellers » injector. The steam both heats the water and forces it through the hose and cleaning « lance » at about twice the original steam pressure. The lance discharges a controlled stream of 180° water at a velocity of 2 mi per minute or about 1 500 gal per hour at

Spray heads are lowered in ice bunkers to melt the ice in Santa Fe refrigerator cars. This does away with hand chipping and shoveling.

240 psi. The operator merely directs the lance at the surface to be cleaned.

The impact of the water is usually enough to do a thorough cleaning job. The mechanical scrubbing action of the jet completely does away with most kinds of dirt and contamination. For stubborn dirt and grease, a solvent or detergent solution can be added automatically through the injector. Often the operator can finish a car without moving more than a few feet from the door. In only about ten minutes, one man can make an average car acceptable for first-class loading; in only about 20 min, he can make a hide car acceptable. The equipment is portable — it is taken to the car — and the car does not require moving.

Some railroads have installed cleaning tracks with a four-to-six in. pitch so that the water and waste material in suspension flows out of the car. Along the tracks are placed black-top or concrete drainage aprons equipped with many drains. Water is supplied to the area through mains and connections at about every third car length.

The Santa Fe's Chicago Car Cleaning facility contains six cleaning machines. The pitch of the track at the facility is about two in.

One of the big jobs on the Santa Fe is the de-icing of refrigerator cars for dry loading on the return trip. In the past, the removal of the ice required hand chipping to clear the ice bunkers and shoveling to remove top-ice. With the present facilities, all the ice can be removed with pressurized hot water. Another big job is the removal of tallow from the sides and doors of meat cars. The hot water, steam and scrubbing action removes the tallow and leaves a clean and fresh surface. After the cars have been cleaned and in most cases upgraded, they are dried either by natural ventilation or by means of forced air and heaters.

The heaters used by the Santa Fe are portable and are moved from one car to the next by means of a flat truck. The bed of the truck is at the same level as the floor of the car. For rapid drying of cars after cleaning, the truck is moved up to the car and the dryer is placed in the car. After drying, the equipment is moved to the next car.

Typical car-cleaning installations.

At North Fond du Lac, Wis., the Soo Line has built a cleaning track 1 000 ft. long with a 6-in. pitch. Along the track a 12-ft. wide black-top strip has been laid with a drain every 50 ft. apart. The Upgrader has been housed in a specially constructed building. Hot water from the machine passes through a water line the length of the track. The hot water line is equipped with take-offs made of standard railroad-type air hose couplings and shut-off valves. Cleaning time averages five to twelve minutes per car.

The Rock Island Railroad car cleaning installation at Cedar Rapids, Iowa, uses two of the Upgraders mounted on a dolly track. The dolly track is alongside the cleaning track, which permits the equipment to be moved to the cars being cleaned. Each night the equipment is placed in a shed made from an old boxcar. This prevents freezing in cold weather. A five-man crew cleans as many as 50 cars every work day, summer and winter. Most of the cars are being prepared for grain and flour loadings.

Another variation in car cleaning installations is the one at St. Joseph, Mo. That facility is used by the Rock Island, Santa Fe and Burlington Railroads. A track 1 400 ft. long has been provided with a 4-in. pitch. The steam generating equipment is permanently mounted on a concrete base and enclosed in a metal cabinet supplied with the machine, and the hot water is fed to the track through a hot water line. Outlets are provided at about every three car lengths. Along the hot water line is located an air line which is connected to the water line with cross-overs and valves. After each day's work, the water line is cleared by allowing compressed air to enter and blow out the water at each outlet.

[625 .13 (73)]

Strengthened members and... new pins revitalize old bridge.

(From the *Railway Track and Structures*. April, 1958.)

Eight pin-connected trusses of a bridge carrying both railroad and highway traffic across the Mississippi river are rehabilitated by strengthening and by replacing pins. By using falsework and a special clamping arrangement, the bridge members are held at proper alinement while worn pins are removed, larger holes bored and new pins inserted.

Additional life through rehabilitation is being given to a 60-year-old bridge spanning the Mississippy river between Rock Island, Ill., and Davenport, Iowa. The eight-span structure, 1 850 ft. long, carries a 24-ft. wide highway below the double-track main line of the Chicago, Rock Island & Pacific. The highlight of the repairs is the replacement of 30 worn pins in the pin-connected trusses.

The $ 1.7-million project also included certain general repairs needed to modernize the structure. All end posts and top chords required strengthening. The top lateral bracing had to be replaced. For the highway portion, all stringers and floorbeams had to be strengthened and the timber roadway and sidewalk replaced with steel grid and filled with concrete. All this work had to be carried out without interruption to the 30 or more daily train movements across the bridge as well as the river traffic through a swing span.

The density of rail traffic did not provide enough time between trains to permit the replacement of a pin. It was decided to support the pin-connected spans temporarily on falsework towers placed in the river to prevent them from collapsing when the worn pins were removed. Each tower consisted of four steel H-piles, about 32 ft. long, framed together at the top with steel beams for jacking purposes. The piles were driven four inches into the rock bottom of the river, using rapid blows from a light double-acting hammer (McKiernan-Terry No. 7).

During driving, piles were guided at the water line by a framework of small angles resting on four pontoons, each 25 ft. long by 6 ft. wide. A crawler crane on a barge, 100 ft. long by 30 ft. wide, completed the water-borne equipment.

The spans were jacked from these towers to relieve the dead-load-stresses in the truss members.

Spidering positions members.

An unusual structural framework, called spidering, was erected around each joint where a pin was to be replaced. The spidering at pin hole M 5, on the upstream truss of span 5, was typical. Pieces of channels, plates and angles forming the spidering were designed as a sectionalized gusset plate to hold all truss members in proper position during reboring operations. Six bolts were used to clamp each eyebar to the spidering and bolts were also used to connect the spidering to holes in the truss members. All temporary and permanent field connections required 80 000 high-strength bolts.

Spidering bolts were left loose during jacking and centering operations. During a slack period between train movements over the bridge, the span was jacked to

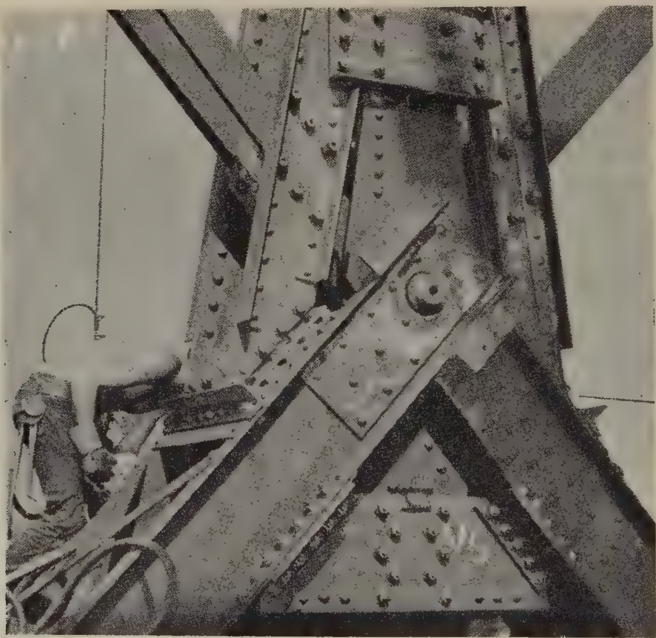
the no-load position. Before removing any pins, positive proof of falsework stability was obtained by allowing trains to cross the span.

After stopping all traffic, a final centering adjustment was made by wedging and shimming the truss members at the pin and by raising and lowering the jacks. All spidering bolts were then tightened. The old pin was then removed by burning it into four or more pieces.

Holes are enlarged.

At the joints where the pins were replaced, the old pins had grooves worn in them as much as one-half inch deep. Also, the pin holes had been enlarged. This called for larger pins and the boring of enlarged holes on exact centers.

The pin holes were enlarged with a special boring machine. An electric motor, acting through a gear train, rotated a cutting bar, 2 ½ in. in diameter by 6 ft. long. A hand wheel on one end of the bar advanced the cutting tool along the hole. At both ends of the hole a cross-head plate, with an adjustable bearing for centering and holding the bar, was bolted to clip angles on a truss member.



Members coming together at pin connection are held in alinement by assembling of plates, angles and channels, called spidering.

Each pass of the cutter enlarged the hole diameter about one-fourth of an inch. The finishing cut provided a maximum clearance of 1/32 in. over the new pin diameter. The new pins varied in diameter from 6 ½ to 10 in. and replaced old 6-in. to 9-in. pins.

A slight change in the schedule of one train provided a six-hour work day for the actual reboring. Sometimes the reboring of

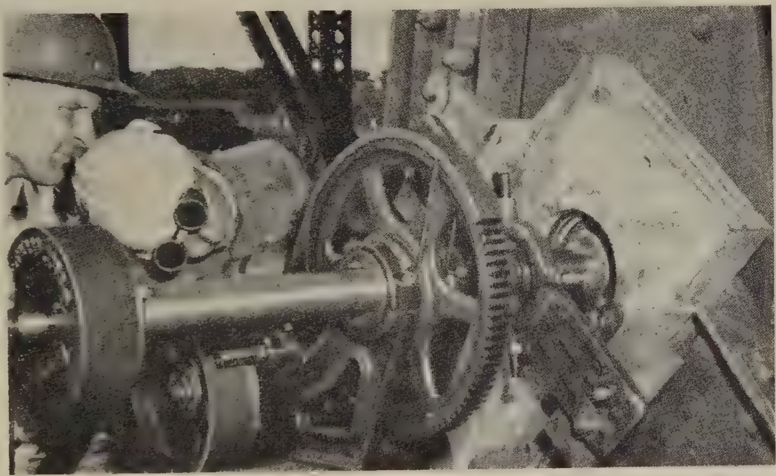
a pin hole could not be finished in the time provided and had to be discontinued overnight to permit traffic over the bridge. When this happened, complete safety was insured for trains by inserting a temporary pin in the partially rebored hole.

Upon completion of the reboring the next day, a permanent pin was installed and the spidering was moved to the next similar joint. Two complete sets of spidering, matching each type of hole rebored, and three complete sets of boring-bar equipment for the whole bridge, were available and permitted the advance preparation of other holes, as well as insuring against lost time due to broken equipment.

Eyebars are adjusted.

After the worn pin holes were rebored, the contractor began the tightening of all main truss eyebars. These had become so loose over the years as to be partially or totally inactive. If turned out that 13 % of the truss eyebars in the bridge were loose, causing overstresses in other truss members. Of these bars, 44 were readily adjusted by turning their turnbuckles.

The remaining nine loose eyebars, having no turnbuckles, were adjusted by the flame-shortening process. A one-foot length of each bar was heated to about 1 600° F with oxyacetylene torches. Clamp plates, gripping the eyebar on both sides of the heated area, were then drawn together by tension rods to upset the heated area slightly. Upon cooling, the eyebar was bearing tightly on the pins at each end.



Machinists watch progress of cutter head as boring machine cuts through worn surface in truss members to provide smooth bearing for new pins.

Adjusts span for expansion.

The repair program included the remedy of an increasingly serious condition at the juncture of the swing span and the adjacent shore span. During hot weather it had become difficult to properly open and close the swing span because the shore span had moved and was binding at the railroad deck. Former temporary emergency measures had consisted of burning off a part of the railroad deck at one end of the swing span to provide better clearance.

This condition was traced to cap stones which had slipped on the abutment. First, the span had to be raised, using falsework erected earlier for reboring, to permit shifting the truss shoes on the abutment. At the same time the abutment masonry was strengthened by pressure grouting through new anchor-bolt holes. Horizontal form was then applied by jacks bearing against jacking posts inclined 45° to the horizontal under the span.

While span No. 1 was being moved, or when repairs required working near any of the transmission towers on top of the bridge, the contractor arranged with the power company to de-energize the six overhead 13 000-V transmission lines. Voice signals, transmitted by walkie-talkie radio directly to the Iowa-Illinois Gas & Electric Company control room in Davenport, kept the workmen constantly informed as to when the lines were actually out of service.

The direct radio communication also made it possible for the power company to have work areas cleared at the bridge on short notice when emergency conditions elsewhere in their network required re-energizing the circuits. The same signaling system was used while transferring wires to two newly erected towers and removing one old tower at span No. 1.

The consulting firm of Modjeski & Masters, Harrisburg, Pa., whose founder, Ralph Modjeski, designed the bridge in 1895, inspected the structure and prepared design plans and specifications for the Corps of Engineers and the Rock Island railroad. Falsework and spidering schemes were designed and the shop and erection drawings were prepared by Plumb, Tuckett & Pikarsky, Gary, Ind. The general contractor, F. K. Ketler Co., Chicago, erected all steel fabricated except the highway deck. All highway reinforcing steel and Greulich grating was erected by Whiting Turner Co., Baltimore, Md.

[656 .23 (73)]

Now-An open door on rates,

by Jervis LANGDON, Jr. (*)

(Railway Age, August 18, 1958*).*

The Tranportation Act of 1958 brings a new concept to the competitive rate rule of the I.C. Act. Guided by a new definition of « unfair and destructive practices », the I.C.C. can no longer impose artificial balances between different forms of transport. Rates of each form must be judged on the facts and circumstances surrounding that form.

In the National Transportation Policy, as everyone knows, there is a prohibition against « unfair or destructive competitive practices » by carriers subject to the Interstate Commerce Act.

On important occasions in the past this has been interpreted to mean that proposed railroad rates, aside from being compensatory and non-discriminatory among shippers, must also reflect what the ICC considers to be a proper relation to the existing costs to the shipper of using truck or barge service. The ICC, in other words, has employed the prohibition as a vehicle for assuring to competing forms of transportation « equal opportunities » to compete. In doing this, it has allowed their different economic capabilities to play secondary roles.

The competitive rate rule (Section 5 of S.3778) incorporated in the Transportation Act of 1958 will bring about a basic change in this regard. While the new rule (**) contemplates « giving due consideration to the objectives of the National Transportation Policy », one of which is the prohibition against « unfair or destructive competitive practices », there is no doubt from the rule as a whole that compensatory and non-discriminatory rates of any form of transportation which are based on its own « facts and circumstances » do not constitute « unfair or destructive competitive practices ».

The effect of the new rule, in other words, is to change the ICC definition of what constitutes « unfair or destructive competitive practices ». No longer will the ICC, in the name of preventing « unfair or destructive competitive practices », be able to require artificial competitive balance for different forms of transportation having different economic characteristics.

The new freedom.

Congress has again emphasized that it is neither « unfair » nor « destructive » for

(**) The new rule is found in Section 15a (3) and reads as follows:

In a proceeding involving competition between carriers of different modes of transportation subject to this Act, the Commission, in determining whether a rate is lower than a reasonable minimum rate, shall consider the facts and circumstances attending the movement of the traffic by the carrier or carriers to which the rate is applicable. Rates of a carrier shall not be held up to a particular level to protect the traffic of any other mode of transportation, giving due consideration to the objectives of the national transportation policy declared in this Act.

(*) Mr. LANGDON is general counsel of the Baltimore & Ohio. He was the A.A.R.'s witness before the House Subcommittee when the competitive rate rule proposed by the Cabinet Committee was under consideration in 1956 and 1957. He served in a like capacity when the same subject came before the Senate Committee on Interstate and Foreign Commerce and the House Subcommittee in May of this year.

the rates of any form of transportation to be judged in the light of the facts and circumstances surrounding that form. Congress has given unqualified endorsement to the following ICC « view respecting the policy of the law subsequent to the Transportation Act of 1940 » :

As Congress enacted separately stated ratemaking rules for each transport agency, it obviously intended that the rates of each such agency should be determined by us in each case according to the facts and circumstances attending the movement of the traffic by that agency. In other words, there appears no warrant for believing that rail rates, for example, should be held up to a particular level to preserve a motor-rate structure, or vice versa (New Automobiles case, 259 I.C.C. at p. 538).

From now on, in brief, the prohibition against « unfair or destructive competitive practices » will not stand in the way of compensatory and non-discriminatory rates by one form of transportation which promise to be effective and to attract competitive business away from another form.

This change in the law will bring about the use of more searching criteria in the formulation of competitive rates. Up to now the railroads, along with trucks and barges, have necessarily followed the same concept of artificial competitive balance to which the ICC has been adhering and which the Congress, in keeping with its intent as first expressed in the Transportation Act of 1940, would now bring to an end — positively. The reason for this is not hard to find.

In the old days, when competition was largely confined to railroads, it was axiomatic that to be competitive Railroad A and Railroad B had to publish the same rates between common points. A higher rate over either railroad would divert traffic to the other. This was so because each provided the same type or character of service. Equal rates are still required in competition between carriers of the same form, no matter what the form.

It was an easy step to extend this concept of equal rates to competition among the forms. A first it was thought truck rates should be the same as railroad rates in dollars and cents. But it later developed that truck rates included the help of the driver in loading and unloading, with the result that equal rates did not produce equal costs from the shipper's point of view. Other so-called « rail disabilities » came to light, and attempts to evaluate them have been made — always in an effort, however, to equalize the real cost to the shipper of using the competing forms of transportation.

What the changes mean.

- The economic capacity of each form of carriage will assume new importance.
- Rates that are compensatory and non-discriminatory can no longer be ruled an « unfair and destructive competitive practice ».
- Use of more searching criteria in formulating competitive rates will result. No old principle of ratemaking is beyond re-examination.
- Equal rates between carriers of the same form will still be required.
- All transport agencies now have the freedom to do more than merely « meet » competition. Each is free to « make » competition.

Making competition.

More recently, when competing truck services have been faster and more flexible, differentials in rail rates have been sought — again the objective of making the two services equally attractive to the shipper. When rail service has been thought to be the equivalent of truck service (as in piggyback) the railroads, despite their cost advantages, have nevertheless published the same rates as the trucks. Competition between rail and barge has employed essentially the same approach, although here it has been the rail rate which, in an effort to provide competitive « equality », has usually been higher.

In fact, the yardsticks which have been applied in the making of competitive rates in the past have supported arguments such as these (as set forth in railroad briefs before the ICC) :

Although there exists in connection with ... traffic, a disparity of costs which justifies a rail-truck differential, it should be noted that the proposed rates do not attempt to fully exploit this cost advantage, but are only such as are necessary to provide an equal competitive opportunity for transportating the traffic in question.

Or as taken from another brief :

... the proposed... rail rates do not fully meet the competition afforded by trucks by virtue of cost and service disabilities of railroad transportation.

... it was the opinion of the shippers that ** these rates ** do not provide a sufficient difference under the truck rates to adversely affect motor carrier operations by regaining disproportionately large volumes of tonnage for the railroads.

Arguments of this kind will be beside the point under the rate rule in the Transportation Act of 1958. For the Congress has now given a green light to the railroads (and equally to the other forms of transportation that have not had green lights), to do more than merely « meet » the competition of other forms of transportation. It has given them all the right « to make » competition, based on their economic capabilities.

Are the railroads ready « to make » such economic competition ?

One look at the record since the war will show that the railroads must be ready. In competing with the trucks, they are already beginning to identify those areas where they have or should have the competitive advantage of a lower cost level, and to determine how and where and when this may profitably be exploited in the interest of increased *net* revenues. Truck rates as such are becoming an irrelevant consideration. Instead, truck costs by the most efficient operators are being taken into account in measuring the potentials of rail competition. And in place of equalized competition, the rails are seeking competitive advantages where economically justified by their lower cost level — just as trucks over the years have enjoyed competitive advantages by furnishing superior service at equal (or nearly equal) costs to the shipper.

Of course, if railroads through piggyback can give the same service as trucks but at compensatory rates which are less, their competitive advantage is an inherent one and fairly solid. In the shorter-haul areas the trucks, with lower costs and flexible service, will continue to have the edge.

New role for research.

In competing with barges, the approach will be the same. Only here, the roles may be reversed. The barges may have the lower costs, and railroads the better service.

For an industry as old as railroads, the transition from « meeting » competition to « making » competition — already started — will not be easy. It will come about, however, through a recognition that none of the old rules and principles of rate-making and service to the shipper is beyond critical re-examination — a re-examination which will be accomplished by combined teams of imaginative and experienced traffic men, operating men, economists, and cost men.

Railroads simply cannot go on trying merely « to meet » their competition. If they do, the same trends that have been apparent since the war will continue — trends, which if projected for another ten years, will put railroads down to 35 % of the total ton-miles of the country. Such a traffic level would not support private ownership even though the country's total ton-miles continue to increase (as they doubtless will).

Some people predict the new competitive rate rule will change nothing and that the ICC will continue to construe the prohibition against « unfair or destructive

competitive practices » as requiring the same sort of competitive balance among the different forms of transportation as enforced in the past. This is hard to believe. The indirect apportionments of traffic which this approach necessarily entails — apportionments which may have no sound economic base — are indefensible, and the Congress made clear its purpose to rule them out for the future. Of course, the ICC will be urged to apply the prohibition in the same old way, and different forms of words will be advanced in an effort to squeeze such an application by the Transportation Act of 1958.

But the ICC, if it upholds technical arguments of this kind, would not be carrying out the intent of Congress. Moreover, it would be providing reasons for the advocacy of a separate railroad commission, along with separate commissions for the other forms. With such a change, trucks complaining of « unfair or destructive competitive practices » on the part of railroads would receive from a railroad regulatory commission exactly the same sort of relief railroads would receive today if complaining before the Civil Aeronautics Board of « unfair or destructive competitive practices » on the part of airline companies.

Separate commissions would make certain that the much-desired national transportation system would evolve through competition, and the present National Transportation Policy — a policy which is neither national nor possible of consistent application — would come to an end.

Much is at stake in the upholding of the true purpose of the new competitive rate rule in the Transportation Act of 1958. The Congress clearly intended that the rates of one form of transportation that are compensatory and do not discriminate among its shippers are no longer to be regarded as « unfair or destructive ».

[625 .143 .4 (73) & 625 .173 (73)]

SAL cuts rail-end repair costs.

(From the *Railway Age*, April 7, 1958).

A new approach to making rail-end repairs is saving the Seaboard Air Line about $ 30 000 a year. Four years of experience with the new practice have convinced the road that it is practicable as well as economical.

The method was developed in 1953. The road's welding superintendent, J. C. Blackburn, had seen his welders use alloy electrodes for building up frogs and switches by the electric-arc process and wondered why he couldn't use an alloy rod to build up rail ends without having to preheat and postheat the rails. After some experimentation, he finally obtained a satisfactory welding rod.

Low carbon the answer.

The electrode is a hardfacing rod called « Forgalloy C », made by The McKay Company of Pittsburgh. Up until two years ago, the road used the Forgalloy M rod, which had a carbon content of about 1.0 %. However, it was noted that the weld metal, in picking up carbon from the parent rail steel, became too brittle, resulting in some spalling. Since the Forgalloy C rod, with its lower carbon content, has been used there has been no trouble from embrittlement. A higher carbon content, it's reported, would necessitate preheating and postheating by the crews.

The Forgalloy C Rod.

- Tensile strength, 116 000 psi; yield strength, 91 000 psi; elongation, 14 % in 2 inches.
- Hardness rating, 25-30 Rockwell C, as deposited; 50-60 Rockwell C after traffic impact.
- Analysis: 42 % carbon, 19.5 % chrome, 1.40 % molybdenum, 4.10 % manganese, and 10 % nickel.

The Seaboard builds up the ends of all relay rail soon after it has been laid and surfaced. It also regularly builds up many miles of its light rail in the track. In the latter case, the track is spot tamped before welding. Reformed angle bars are applied in advance of the welding work by a 15-man gang. This force, made up from the sections, works only as needed to keep ahead of the welding work. It applies the bars at the rate of about 250 joints a day, and also does spot tamping.

The welding gang is a 10-man crew comprised of two welders, two welder helpers, 5 grinding-machine operators and a cook. It is supervised by a foreman and an assistant foreman. This compares with 21 men formerly employed for the same work.

The present welding gang has two 300-A arc welders. In addition, the outfit is equipped with two Railway Track-work P-45 surface grinders and a P-11-S cross grinder.

The rail ends are being built up at an average rate of 216 joints per day. This includes the insulated joints encountered as well as run-of-the-mill short welds and those 12 inches and longer. Last year the road built up 51 475 joints on 190 track-miles at a cost of $ 1.20 per joint. In 1953, before the present welding method was adopted, 65 820 joints were welded at an average cost of $ 1.65 per joint.

To maintain production, the gang is not stopped for doing any other welding work. Only the rail ends are built up, each welder depositing from 30 to 37.5 pounds of metal each day. Rails with split ends are not built up but are replaced ahead of the welding work. The gang uses a portable phone to check traffic with the dispatcher.

The occasional horizontal splits and chipped ends found at the ends of the rails, however, are repaired. This is done by using a cleaver to knock out the separated portion and by reversing the polarity of the arc welder to remove enough metal to eliminate all cracks. The area is then rebuilt in the usual manner.

The Seaboard is well satisfied both with the performance of the gang and with the welds themselves. Many specimens of the built-up ends have been sawed off and etched for observing the grain structure. No sign of crystallization of the parent metal has been found.

By using the present method, the road estimates that it is saving about $ 30 000 a year. Although the special electrode costs more than most rods, a big saving is made in labor. In addition, there is no interruption to train movements as trains are allowed to run over the work at any time. Nor is there any rail droop from allowing traffic to pass. No trouble has been experienced with the Cadweld rail-head bonds as the welding heat does not soak into the rail that far.

The present method of building up rail ends has been used long enough to prove to the Seaboard that the welds are sound and stand up under traffic. The road reports there have been practically no weld failures. Recent inspections of the 1954 work show that the welds have more years of service life in them. The road confidently expects that the arc welds will last seven to eight years before rebuilding or slotting again becomes necessary.

NEW BOOKS AND PUBLICATIONS.

[**656** (02]

LAMALLE (Ulysse), Civil Engineer (Mining), A.I.Lg. Emeritus Professor of the Railway Operating Course at the University of Louvain, Honorary General Manager of the Belgian National Railways, Member of Honour of the International Railway Congress Association. — **Cours d'Exploitation des Chemins de fer.** — Tome I : **Exploitation Commerciale.** — *(Railway Operating Course — Volume I : Commercial Operation. The transport contract Tariff principles. Maximum utility. Financial management. Costs — Marginal costs. The drama of the railway. Co-ordination. Europeanisation.)* — 5th edition. — One volume (7 7/8 × 10 1/4 in.) of 228 pages, with 72 figures. — 1958, Louvain, Libraire Universitaire, Ch. Uystpruyst, publisher, 10 rue de la Monnaie, and Paris, Dunod, Publishers, 92, rue Bonaparte.

Indefatigable pursuing the presentation of his important « Railway operating course », Mr. LAMALLE has just published the 5th edition of the volume devoted to *Commercial Operation*.

Although the main ideas of the work — financial management, competition with other methods of transport — remain the same as in the previous edition, the author characterises in this new edition the evolution which these have undergone in the ten years that have passed.

The first part of the course begins by a report of the Belgian laws which govern railway transport. The author shows the precautions with which the public authorities have surrounded themselves to safeguard the general interest in view of the monopoly which the railway enjoyed at the time the law was passed (1891).

The author then reports the main principles on which the tariffs are based. Here again, he stresses the differences between the « public service » transport undertaking and the private transport undertakings.

Finally, he studies the integration of the railway in the general economy and derives from his report the important notion of partial costs and the value of multiple rates.

After this first part which is doctrinal in character, the author begins his study of the financial management properly speaking of the railway. He defines the fundamental mechanism, justified by the need to control the working of the undertaking.

Going on to deal with the calculation of the costs, the author introduces, taking as his basis the most recent work of the I.R.U. (U.I.C.), the idea of marginal costs, « the cost of additional traffic within the capacity limits of the existing installations, in the case of Administrations who would be in a position of full employment as regards staff and stock ». He ends this important chapter by reporting the method of calculating the costs recently recommended by the I.R.U (U.I.C.).

The method of appreciating the operating results and the lessons to be learnt therefrom are also the subject of a detailed report, in which the author stresses the ever increasing importance of statistics. In this connection, he gives some elementary information about electronic calculators which are becoming more and more indispensable in this field.

Then coming to the thorny problem of competition between the different methods of transport, the author examines the position of the road and waterways compared with the railway. In particular, he deals at length with road transport for which he establishes costs and comparing these with the cost of railway transport, draws attention to the out-of-date clauses in the legislation affecting the railway.

Going on to analyse the heavy handicap the railway is under in fulfilling its mission to transport, the author defines the fundamental objectives which would allow it to retain its proper place in public transport — reduced costs, increased productivity, improvement in the quality of the services offered — and shows the progress made in these fields in recent years, on both the national and European planes.

To sum up, on account of the amplitude of the subject dealt with, its high intellectual plane, the well-founded arguments and clarity of the report, Mr. LAMALLE'S *Commercial Operating Course* is more than an invaluable reference work for university students, and will also be read with profit by all those who, for no matter what reason, are interested in the science of transport.

R. S.

[**625** .2]

KOFFMAN (J.L.) Member of the Institution of Locomotive Engineers. — **Vibrational aspects of bogie design.** — Study No. 580 published in the *Journal of the Institution of Locomotive Engineers*, Vol. 47, No. 6, 1957 .— 138 pages with illustrations. Price of the journal : 15 s./— to non members of the I.L.E. and 7 s./6d to members.

The increased speeds and reduced weight of rolling stock, together with the desire to improve the comfort of the stock and reduce maintenance costs, involves a thorough knowledge of the dynamics of the running parts.

Mr. KOFFMAN in the present study has collected together and classified the results of the studies on this subject made by a great many research workers.

After recalling the criteria which may be used as a basis for the evaluation of the comfort of the stock, he systematically reviews the different oscillating movements which a vehicle can undergo. He examines the causes, indicates the method of calculating the actual frequencies and studies the influence of the damping out on the amplitude of forced oscillations. As far as possible, he compares the calculated theoretical values with the results of experimental measurements.

The author completes his study by a reasoned description of some types of modern coach and locomotive bogies, and by giving certain general conclusions concerning the design of bogies.

The study also includes a very full bibliography as well as several appendices in which the author recalls the fundamental principles of the theory of vibrations, examines the method of acting of various types of springs, comments upon the method of determining the actual frequencies, the position of the centre of gravity and moments of inertia, and applies the theoretical studies to an actual BB electric locomotive.

The discussions of the study at the meeting, which are also given, by throwing further light upon certain points, increase the interest of the masterly study made by Mr. KOFFMAN of a fundamental question in the design and construction of rolling stock.

R. S.

NOTE

« Kurzauszüge aus dem Schrifttum für das Eisenbahnwesen. »

(Brief extracts from publications concerning the railways.)

The Deutsche Bundesbahn proposes to make available to the general public the bibliographical review : « Kurzauszüge aus dem Schrifttum für das Eisenbahnwesen », which to date has been published exclusively for the internal needs of the railway. These « Kurzauszüge », which are already in their sixth year of publication, offer, not only for libraries and information services extraneous to the D.B. but to extensive circles in industry, science and economics the possibility of informing themselves concerning technical publications dealing with transport and the railways published throughout the whole world.

In close collaboration with the European and overseas Administrations, all the technical literature published throughout the whole world is gone through to discover all items that are of interest to the railways and the data in question are published in the « Kurzauszügen ». About 3 000 reviews, indexed on the universal decimal classification (C.D.U.) give each year a review of railway life throughout the world. All the technical fields in which the railway is interested : traction, permanent way, technical operating, commercial operating, tariffs, legislation and jurisprudence are dealt with in a clear fashion.

The « Kurzauszüge » appear every month and are on sale at « Paul Giese Verlag » at Offenbach (Main), 77, Bettinastrasse. The price of each issue is about 5 DM. For all further information, those interested should get in touch with the Information Services of the Deutsche Bundesbahn, Offenbach (Main), 59, Bieberer Strasse.

PRINTED IN BELGIUM

M. WEISSENBRUCH & Co. Ltd.
Printer to the King
(Manag. Dir. : P. de Weissenbruch,
238, chaussée de Vleurgat, XL)
Edit. responsible : P. Ghilain